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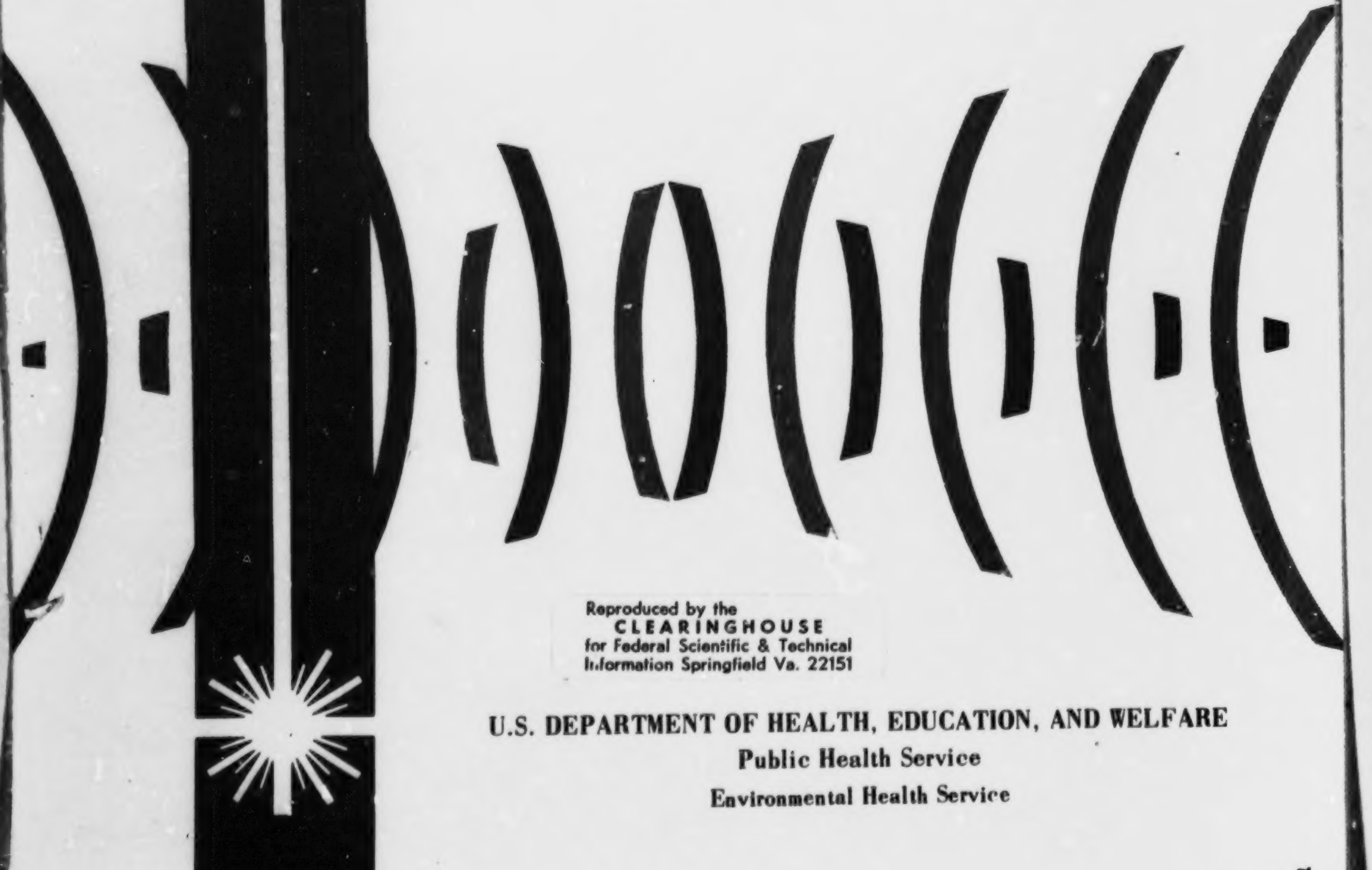
LABORATORY TESTING AND EVALUATION OF COLOR TELEVISION RECEIVERS ACQUIRED DURING THE IN-PLANT SURVEY



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DIVISION OF ELECTRONIC PRODUCTS

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BRH / DEP 70 - 6

LABORATORY TESTING AND EVALUATION OF COLOR TELEVISION RECEIVERS ACQUIRED DURING THE IN-PLANT SURVEY

Thomas M. Smith, Paul S. Ruggera, and Stephen W. Smith

Product Testing and Evaluation Branch
Division of Electronic Products

APRIL 1970

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service
Bureau of Radiological Health
Rockville, Maryland 20852

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FOREWORD

The Bureau of Radiological Health, formerly the National Center for Radiological Health, continues to carry out a national program designed to reduce the exposure of man to hazardous ionizing and nonionizing radiation.

Within the Bureau, the Division of Electonic Products (1) develops and administers performance standards for radiation emission from electronic products, (2) studies and evaluates emissions of and conditions of exposure to electronic product radiation and intense magnetic fields, (3) conducts or supports research, training, development, and inspections to control and minimize such hazards, and (4) tests and evaluates the effectiveness of procedures and techniques for minimizing such exposures.

The Bureau publishes its findings in Radiological Health Data and Reports (a monthly publication), the Environmental Health Series, Public Health Service numbered reports, appropriate scientific journals, and Division technical reports.

The technical reports of the Division of Electronic Products (DEP) allow comprehensive and rapid publishing of the results of intramural and contractor projects. The reports are distributed to State and local radiological health program personnel, Bureau technical staff, Bureau advisory committee members, university radiation safety officers, libraries and information services, industry, hospitals, laboratories, schools, the press, and other interested individuals. These reports are also included in the collections of the Library of Congress and the Clearinghouse for Federal Scientific and Technical Information.

I encourage the readers of these reports to inform the Bureau of any omissions or errors. Your additional comments or requests for further information are also solicited.

John C. Villforth

John C. Villforth
Director
Bureau of Radiological Health

PREFACE

Under the authority granted to the Secretary, Department of Health, Education, and Welfare by Public Law 90-602, the "Radiation Control for Health and Safety Act of 1968," the Division of Electronic Products conducted a field survey of domestic television manufacturers from June 1969 to September 1969 to determine the X-ray emitting capability of television receivers manufactured after October 18, 1968. During this survey various receivers, identified as being capable of emitting X-radiation, were selected for additional Division of Electronic Products laboratory testing. This report describes the laboratory tests on these receivers, presents the data obtained, and makes recommendations for the reduction or elimination of X-radiation emissions.

It should be clearly noted that the receivers tested in the laboratory and the data presented in this report do not represent a statistical sample of all television receivers being sold today, but were selected under several specific considerations as mentioned in the report.

Robert L. Elder

Robert L. Elder, Sc.D.
Acting Director
Division of Electronic Products

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LABORATORY TESTING AND EVALUATION OF COLOR TELEVISION RECEIVERS ACQUIRED DURING THE IN-PLANT SURVEY

I. INTRODUCTION

During the period from June 1969 to September 1969, the Division of Electronic Products, in cooperation with 22 domestic television manufacturers, engaged in a field survey to determine the X-ray emitting capability of television receivers manufactured after October 18, 1968 (1). The survey was conducted under the authority granted to the Secretary, Department of Health, Education, and Welfare by Public Law 90-602, the "Radiation Control for Health and Safety Act of 1968." Section 356 (a) (4) requires the Secretary to establish and carry out an electronic product radiation control program to protect the public health and safety from electronic product radiation and among other activities to study and evaluate the emission of, and conditions of exposure to, electronic product radiation.

When receivers were identified during the in-plant survey as being capable of emitting X-radiation, a determination was made whether to purchase that receiver for additional laboratory tests. This determination was based on the following considerations:

(1) Only receivers which showed X-radiation emission capabilities above 0.5 mR/hr under field test conditions and for which operating characteristics data were available were considered for purchase. In some instances several receivers of the same chassis design (with different picture tube size) fell into this category. The receiver selected for purchase was the one giving the highest radiation readings.

(2) The actual receiver purchased was, in most instances, the one which was field tested and found to emit X-radiation in excess of 0.5 mR/hr. Reasons for not purchasing the receiver which had been tested included:

   a. A component of the receiver had been destroyed during testing.

   b. Changes were made on the receiver subsequent to testing.

   c. The selection of the receiver for purchase was made at a later date and the original receiver tested could not be located.

In those instances where the receiver which was tested could not be obtained, an identical model was purchased.

(3) Receivers showing X-radiation emission above 0.5 mR/hr during the defective shunt regulator tube test and not during the other field test procedures performed on the receiver were not selected for additional testing by the Division of Electronic Products because the field tests provided sufficient information to determine the cause of excessive X-radiation.

Using the aforementioned considerations, the Product Testing and Evaluation Branch has received and tested 22 color television receivers. Of these sets, 21 were purchased and one was obtained on loan from the manufacturer. The testing began in late September 1969 and was completed by mid-November 1969. The laboratory tests on these receivers repeated the field tests and identified design and operating characteristics of television receivers that may be used to reduce or eliminate X-radiation emissions. The receivers were also tested for X-radiation emissions under the conditions of the various phases of the performance standard for television receivers (see Appendix A - the three phases of the standard are Sections 78.210 (c) (3) (i), (ii), and (iii)). It should be noted that these tests under the conditions of the standard were conducted before an applicable standard was in effect.

II. TEST OBJECTIVES

The test objectives of the laboratory product testing of color television receivers were as follows:

(1) To verify measurements made during the in-plant TV survey.

(2) To develop data on X-ray emission as compared to the three phases of the performance standard for control of TV set X-radiation under the radiation Control for Health and Safety Act (see Appendix A).

(3) To identify specific receiver components emitting excessive radiation and the cause of such emissions.

(4) To prepare recommendations for reducing or eliminating excessive X-radiation.

III. TESTING PROCEDURES

Setting for Normal Operation

It was felt that before any laboratory tests were made on the receivers the sets should be set up for normal operation to be sure that they were not maladjusted when the measurements were made. The procedure to set up color television receivers for normal operation was as follows:

(1) High Voltage Adjustment

After connecting a voltmeter to the picture tube anode, the brightness and contrast controls were turned to their minimum positions. The high voltage control was adjusted to produce the voltage recommended by the manufacturer (at correct line voltage).

The contrast control was adjusted to give a good picture. The brightness control was turned back and forth (from maximum to minimum) to see if the set was regulating properly. If it was not regulating properly, normal service procedures were followed to correct the problem.

(2) Centering

A color bar generator was used to see if the picture was centered both horizontally and vertically. Any necessary adjustments were made. Also, the height and vertical linearity were adjusted as necessary.

(3) Purity Adjustments

Step 1 of "Convergence Adjustments" was performed. If the picture tube appeared to be magnetized, a degaussing coil was used to demagnetize tube and mounting brackets. A blank raster was obtained.

The red screen control was turned to maximum. The blue and green screen controls were turned to minimum. The deflection yoke was loosened and moved rearward until it was against the convergence yoke assembly.

The tabs on the purity magnet were adjusted and the assembly rotated until a red spot appeared at the center of the picture tube. The deflection yoke was slid forward to obtain a uniform red over entire picture tube face.

(4) Gray Scale Adjustments

A black and white picture or a color picture was tuned in with the color control set at minimum. The kine bias (CRT bias) control was turned to minimum (counterclockwise). The red, blue and green screen controls were turned to minimum. The normal-service switch was moved to the service position. The screen controls were advanced one at a time until each produced a barely visible line.

PRECEDING PAGE BLANK

If one or more controls failed to produce a line, that screen control was left at maximum and the kine bias control advanced until a barely visible line appeared. Then the other two screen controls were readjusted for a barely visible line. The normal-service switch was returned to the normal position.

The blue and green video drive controls were adjusted to eliminate coloring in the light and dark areas of the picture.

The brightness and contrast controls were turned to maximum (fully clockwise). The CRT bias control was adjusted until the picture bloomed (distorted), then the control reduced to the point just below where the picture returned to normal.

If the set had a brightness limiter control, the brightness control was turned to maximum, fully clockwise, and the contrast control to mid-range. The brightness limiter control was adjusted until the picture bloomed (distorted). Then the control was reduced to the point just below where the picture returned to normal.

(5) Dynamic Pincushion Adjustments

The side pincushion was a fixed correction and no adjustments were provided on the chassis. Top and bottom pincushion was factory adjusted and readjustment was seldom needed. If necessary, top and bottom pincushion were corrected by adjusting for straight horizontal lines at the top and bottom of the screen.

A crosshatch generator was connected to the antenna terminals and the set adjusted for a normal crosshatch pattern. The top-bottom pincushion amplitude control was turned fully counterclockwise.

The top-bottom pincushion phase coil was adjusted to move the curvature to the center of the screen. The top-bottom pincushion amp. control was readjusted for straight horizontal lines at top and bottom of the screen. The above steps were repeated if necessary.

(6) Convergence Adjustments

The procedure used for the convergence of the receivers tested is located in Harvard W. Sams and Company, Incorporated Photofact Folder, Set 1000, Folder 3, Page 24.

(7) AGC Adjustment

A strong TV station was tuned in and the AGC control advanced until instability appeared in the picture (pulling, jitter, overload, etc.). The control was reduced to the point just below the instability and all available stations checked for proper AGC action.

Actual Testing

The procedure for the actual laboratory testing of the receivers for X-ray emitting capabilities was as follows:

(1) Instruments used in the testing were listed.

(2) Set description information was obtained from the receiver as called for on page 1 of the data sheets. Each tube "EIA No." and "Brand" was copied from the tube in question. The EIA No., which denoted manufacturing source, did not always correspond to the brand as entered on the data sheets.

(3) The test equipment was connected to the receiver.

(4) The background reading was placed on form.

(5) The Stoms meter was put 5 cm. from the picture tube at its center.

(6) The receiver was turned "on."

(7) The strongest TV station in the area was tuned in and the controls (brightness, contrast, color, tint, fine tuning, etc.) adjusted to obtain a good picture.

(8) The tuner was switched to the channel receiving the color bar generator making sure the signal from the generator matched that of the strongest station.

(9) The picture tube voltage, picture tube current, shunt regulator tube current, and line voltage were recorded on the appropriate form (Card Type 6).

(10) A complete survey of the receiver was made using the Stoms meter to locate the area of maximum emission.

(11) The location, size of beam, and the readings were recorded on the data sheet (for location see Fig. 2).

(12) A reading was taken with the Victoreen 440 RF at the same location and that value recorded.

(13) The Stoms meter was replaced in front of picture tube and the high voltage adjustment increased to its maximum position.

(14) The line voltage was increased gradually from 120 VAC to 135 VAC while varying brightness and CRT bias to obtain maximum emission.

(15) Time was allowed for conditions to stabilize.

(16) The brightness control was adjusted until a maximum X-ray reading was obtained on the most sensitive X-ray instrument, then a measurement was made with the 440 RF.

(17) If no maximum reading could be obtained, brightness was turned to its maximum value.

(18) The picture tube voltage, picture tube current, and shunt regulator tube current (if applicable) were recorded on Card Type 2. The mA readings were recorded to the nearest hundredth and the kV readings to the nearest tenth.

(19) A survey of the entire set was made with the Stoms meter to locate the area of maximum emission.

(20) The location and the reading were recorded on the data sheet. The Stoms reading was recorded to the nearest hundredth, net of background.

(21) A reading was taken with the Victoreen 440 RF at the same location and that value recorded to the nearest tenth, net of background.

(22) The brightness control was adjusted for minimum brightness.

(23) Steps 18-21 were repeated.

(24) The line voltage was decreased to 130 VAC.

(25) Steps 16-21 were repeated. Another Card Type 2 form was used and V_L = 130 VAC written on the top of the page. The measurements obtained in this Step were taken under the conditions of Phase II of the performance standard (see Appendix A).

(26) If any measurement in Step 25 was greater than 0.5 mR/hr, the line voltage was decreased to obtain just 0.5 mR/hr at that position and all meter readings were recorded on Card Type 7.

(27) The line voltage was reduced to 120 VAC and the receiver turned "off."

(28) The shunt regulator tube was replaced with a faulty tube.

(29) The Stoms meter was placed in front of picture tube.

(30) The receiver was turned "on."

(31) Steps 14-21 were repeated (Also the H.V. rectifier tube was checked with the Stoms meter while at minimum brightness). V_L = 135 VAC.

(32) The line voltage was decreased to 130 VAC.

(33) Steps 18, 20, 21 were repeated. Card Type 2 with 130 VAC line notation was used. The measurements obtained in this Step were taken under the conditions of Phase III of the performance standard (see Appendix A).

(34) If the radiation in Step 33 was greater than 0.5 mR/hr, the line voltage was decreased to obtain just 0.5 mR/hr at that position and all meter readings were recorded on Card Type 7.

(35) If the reading at 135 VAC line (defective shunt) was 0.5 mR/hr or greater, the line voltage was increased to 135 VAC.

(36) The front brightness control was adjusted to five (5) different positions and the picture tube voltage and current recorded at each position. The picture tube data sheet, Card Type 4 was used, but it was noted on the sheet that it was being used for the defective shunt regulator tube test and "DDD" was placed in the spaces for location.

(37) The receiver was turned "off."

(38) The original shunt regulator tube was replaced in the receiver.

(39) The receiver was adjusted for normal operation (recommended high voltage and minimum brightness at 120 VAC line).

(40) The appropriate survey meter was placed at the location of the maximum radiation reading.

(41) The brightness control was adjusted for maximum emission.

(42) The line voltage was increased to 130 VAC and all meter readings recorded on Card Type 6. The measurements obtained in this Step were taken under the conditions of Phase I of the performance standard (see Appendix A).

(43) The test procedure to follow for further tests was chosen and entered on the data sheet. Criteria for decision:

a. Test on the picture tube yielded a value greater than 0.5 mR/hr on the 440 RF and test on the shunt regulator tube yielded a value greater than 0.5 mR/hr on the 440 RF/C or 8000 units on the Stoms meter. Steps 44, 45, and 46 were performed.

b. Test on the picture tube yielded a value greater than 0.5 mR/hr. Steps 44 and 45 were performed.

c. Test on the shunt regulator tube yielded a value greater than 0.5 mR/hr on the 440 RF/C or 8000 units on the Stoms meter. Steps 44 and 46 were performed.

d. Test with the defective shunt regulator tube yielded a value greater than 0.5 mR/hr. Step 36 was performed.

e. None of the test yielded a value greater than 0.5 mR/hr on 440 RF or 440 RF/C from the picture tube; or 8000 units on the Stoms meter or 0.5 mR/hr on the 440 RF/C from the shunt regulator tube. No further tests were performed.

(44) Typical Operating Conditions

a. With Shunt Regulator Tube
1. The receiver was turned "on."
2. The rear panel high voltage control was set at its minimum point.
3. The line voltage was set at 110 VAC.
4. The front brightness control was adjusted to give an upscale reading on the two milliammeters.
5. The high voltage setting, line voltage shunt current, picture current, total current, and picture voltage were recorded on the data sheet (Card Type 3).
6. Steps 4 and 5 were repeated at line voltages of 115 VAC, 120 VAC, 125 VAC, 130 VAC, and 135 VAC.
7. The rear panel high voltage control was adjusted to 3 other intermediate positions and its maximum position and Steps 3-6 repeated.
8. The receiver was turned "off."
9. The high voltage supply was discharged.

b. Without Shunt Regulator Tube
1. Same as A.
2. Same as A.
3. Same as A.
4. The front brightness control was adjusted to give values of picture tube current equal to 0, 0.1, 0.2, 0.3, 0.5, 1.0, 1.5 mA or maximum.
5. The high voltage setting, line voltage, picture current, and picture voltage were recorded on the data sheet (Card Type 3).
6. Same as A.
7. Same as A.
8. Same as A.
9. Same as A.

(45) Picture Tube Test

a. The Victoreen 440 RF was placed at the point of maximum emission found in the radiation emission measurements.

b. The receiver was turned "on."

c. The front brightness control and the rear panel high voltage control were adjusted to various positions that produced an exposure rate of 0.5 mR/hr. The line voltage was increased to 135 VAC if necessary to achieve that exposure rate.

d. The values of picture tube voltage, picture tube current, and line voltage which produce an exposure rate of 0.5 mR/hr were recorded (Card Type 4).

e. The receiver was turned "off."

f. The high voltage supply was discharged.

(46) Shunt Regulator Tube Test

a. The Stoms meter was placed at the point of maximum emission with minimum brightness found in the radiation emission measurements.

b. A sheet of lead was placed between the picture tube and the shunt regulator tube, if shielding for isolation was not already there.

c. The receiver was turned "on."

d. The front brightness control and rear panel high voltage control were adjusted to various positions that produced an exposure rate of 8000 units from the shunt tube. The line voltage was increased to 135 VAC if necessary to achieve that exposure rate.

e. The values of shunt voltage, shunt current and line voltage which produce an exposure rate of 8000 units were recorded (Card type 5).

f. The receiver was turned "off."

g. The high voltage supply was discharged.

(47) After these tests, the receiver was adjusted for normal operation (recommended high voltage and minimum brightness at 120 VAC line).

The procedure for the proper connection of the test equipment to the television receivers was as follows (see fig. 1):

(1) The "plus" side of the milliammeters were connected together with a short piece of wire.

(2) A wire with a picture tube anode cap was connected between the picture tube and the "negative" side of the picture tube milliammeter.

(3) A wire with a shunt regulator tube anode cap was connected between the shunt regulator tube and the "negative" side of the shunt tube milliammeter.

(4) A wire was connected between the "plus" side of the picture tube milliammeter to the high voltage source (usually the cathode of the rectifier tube).

(5) A wire was connected between the "plus" side of the shunt regulator tube milliammeter and the high voltage connection on the electrostatic voltmeter.

(6) The negative side of the electrostatic voltmeter was connected to the chassis ground of the receiver.

(7) A discharge wire was connected to the chassis of the receiver for the purpose of discharging of the high voltage supply.

(8) The receiver "cheater" cord was plugged into the extension cord.

(9) The AC voltmeter was plugged into the extension cord.

(10) The extension cord was plugged into the Variac.

(11) The Variac was plugged into the line regulator.

(12) The line regulator was plugged into the 120 VAC outlet.

(13) The leads from the signal generator were connected to the VHF antenna terminals.

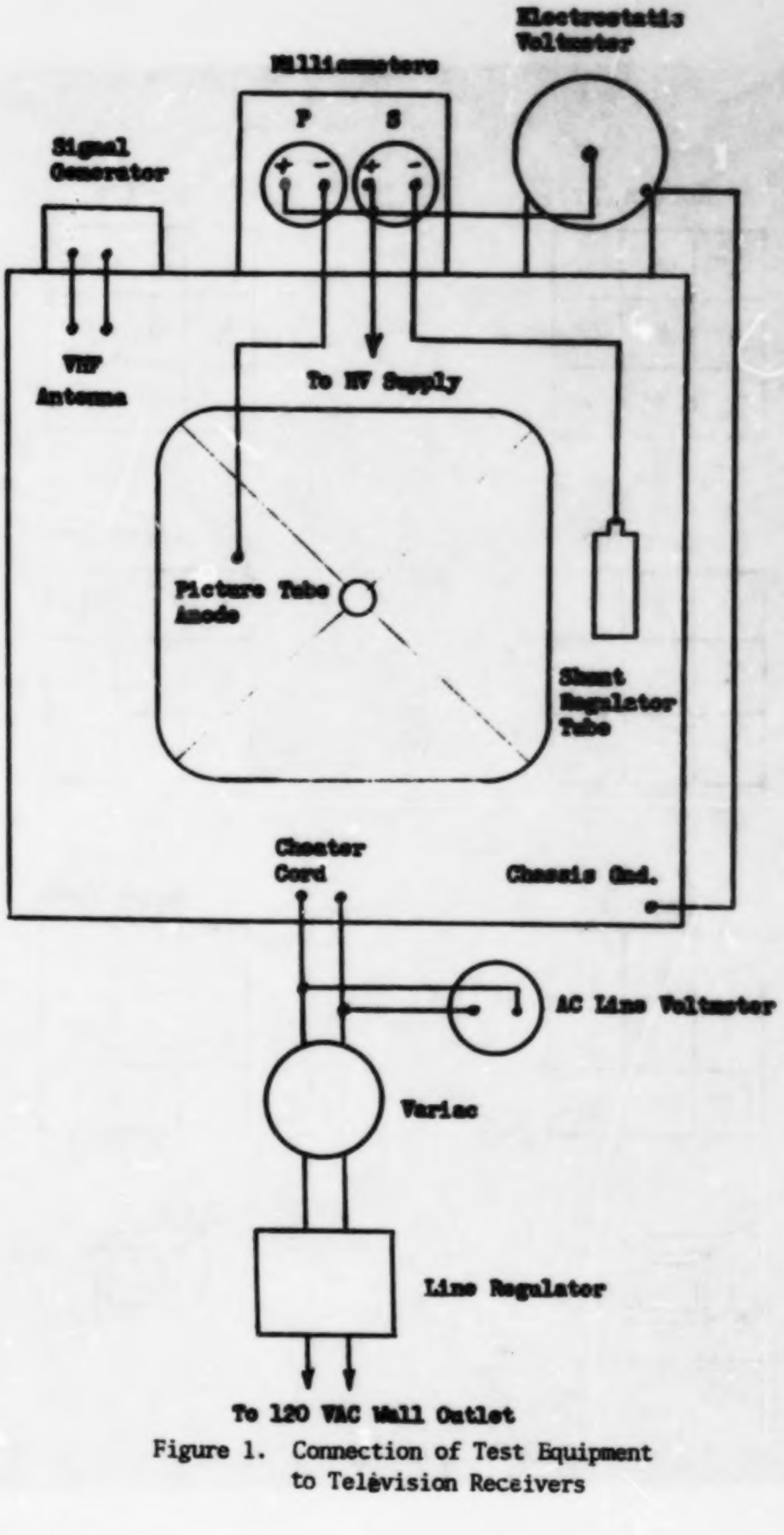
Electrostatic Voltmeter
Milliammeters
P
S
Signal Generator
VHF Antenna
To HV Supply
Picture Tube Anode
Shunt Regulator Tube
Cheater Cord
Chassis Gnd.
AC Line Voltmeter
Variac
Line Regulator
To 120 VAC Wall Outlet

Figure 1. Connection of Test Equipment to Television Receivers

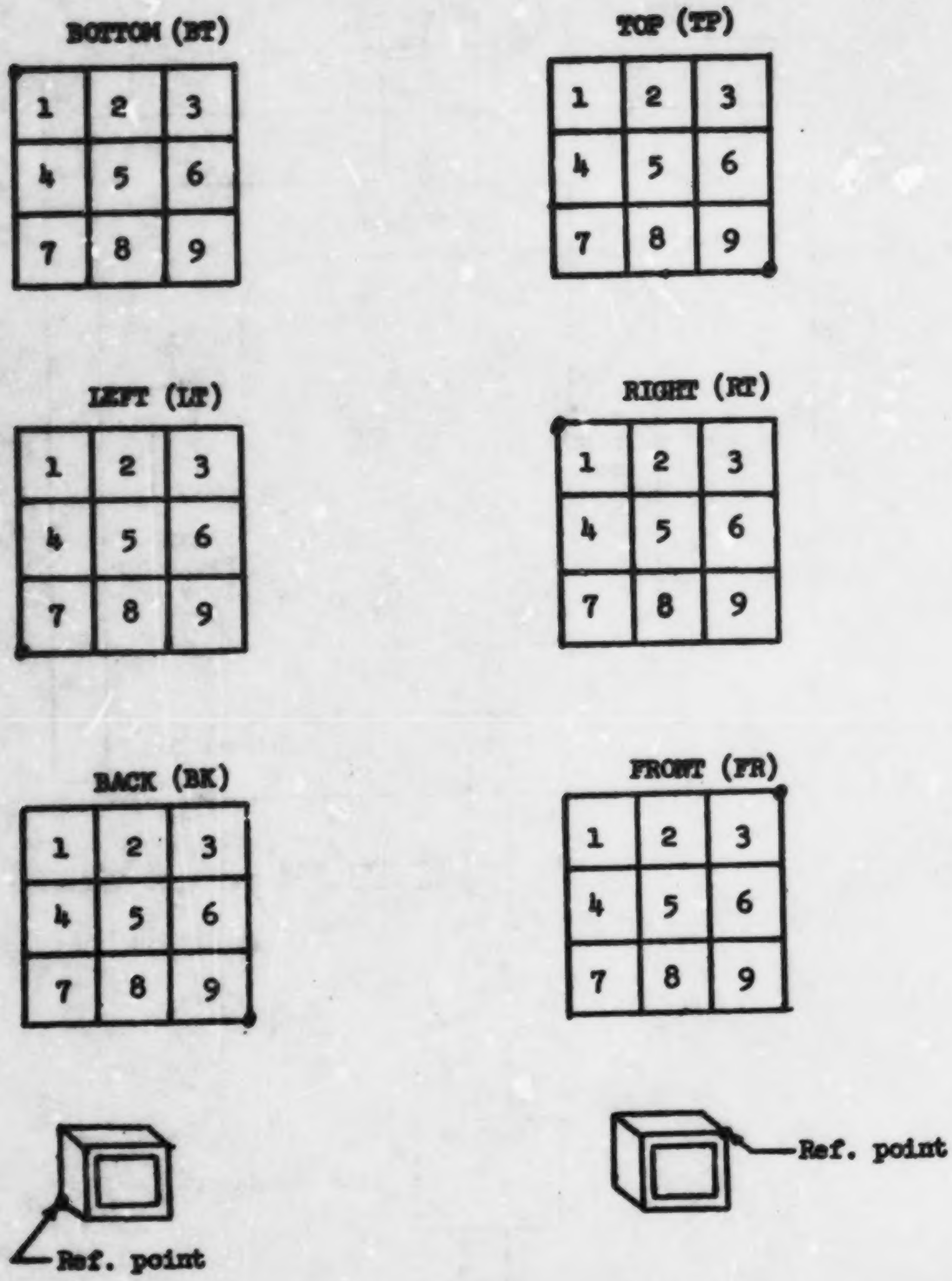
BOTTOM (BT)
TOP (TP)
LEFT (LT)
RIGHT (RT)
BACK (BK)
FRONT (FR)
1
2
3
4
5
6
7
8
9
Ref. point
Ref. point

Figure 2. Location of Meter

Page 1 of 15
Test No.
Card Type 1

TESTING AND EVALUATION OF COLOR TELEVISION RECEIVERS FOR X-RADIATION EMISSIONS

DATA SHEETS

Card Seq. No. 1

Manufacturer of Set:

Brand Name:

Import (Y = Yes, N = No):

Model Number:

Chassis Number:

Serial Number:

Cabinet Style:
(E = Home Entertainment Unit,
P = Portable, C = Console,
M = Other)

Cabinet Material:
(P = Plastic, M = Metal,
W = Wood)

Production Date: mo yr

Color (Y = Yes, N = No):

Card Seq. No. 2

Picture Tube: EIA No. brand type

Rectifier Tube: EIA No. brand type

Shunt Regulator Tube: EIA No. brand type

Survey Date: mo day yr

Team:

Signature: ______________________

Coding Notes: See "DEP Company Codes" for coding of manufacturer names and brand names. Data should be left-justified. When data is not available, enter NA. If there is no shunt regulator tube, enter NONE for type.

Page 2 of
Test No.
Card Type 2

MEASUREMENTS OF MAXIMUM RADIATION EMISSIONS

	Picture Tube	Minimum Brightness	Defective Shunt
Victoreen 440 RF (mR/hr)			
Stoms Meter (units)			
Picture Voltage, V_p (kV)			
Picture Current, I_p (mA)			
Shunt Current, I_s (mA)			
Location: Side (FR = Front, BK = Back, LT = Left, RT = Right, TP = Top, BT = Bottom)			
Maximum Dimension of Beam (L = larger than 2 inches, S = smaller than 2 inches)			
Section of Side (1-9; see coding guide on Location of Meter)			

Test Procedure for Further Tests:

(A. Normal procedure - all
B. Normal procedure - picture tube
C. Normal procedure - shunt regulator tube
D. Test with defective shunt regulator tube
E. No further tests to be made)

Signature: ____________________ Date: ____________________

Page [ ] of [ ]

Test No. [| | |]

Card Type [3]

REGULATION AND OPERATING CONDITIONS DATA

Card Seq. No.	High Voltage Setting	Line Voltage V_L (V)	Shunt Current I_s (mA)	Picture Current I_p (mA)	Total Current I_t (mA)	Picture Voltage V_p (kV)
1						
2						
3						
4						
5						

Signature: ______________________ Date: ______________________

Page ⌊ ⌋ of ⌊ ⌋

Test No. ⌊ ⌋

Card Type ⌊4⌋

PICTURE TUBE DATA

Radiation - 0.5 mR/hr

Location of Meter ⌊ ⌋

Card Seq. No.	Picture Voltage V_p (kV)	Picture Current I_p (mA)	Line Voltage V_L (V)		Picture Voltage V_p (kV)	Picture Current I_p (mA)	Line Voltage V_L (V)
1							
				4			
2							
				5			
3							

Signature:________________________ Date:________________________

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Test No. ☐☐☐☐

Card Type 5

Tube Type ☐☐☐☐☐☐

MFR Code ☐☐☐☐☐☐

Location of Meter ☐☐☐

SHUNT REGULATOR TUBE DATA

Radiation = 0.5 mR/hr

Card Seq.No.	Shunt Voltage V_s (kV)	Shunt Current I_s (mA)	Line Voltage V_L (V)		Shunt Voltage V_s (kV)	Shunt Current I_s (mA)	Line Voltage V_L (V)
1							
				4			
2							
				5			
3							

Signature: ____________________ Date: ____________________

Page ☐☐ of ☐☐

Test No. ☐☐☐☐

Card Type 6

MEASUREMENTS AT NORMAL OPERATING CONDITIONS

	Normal Picture	Maximum Emission
Victoreen 440 RF (mR/hr)		
Stoms Meter (units)		
Picture Voltage, V_p (kV)		
Picture Current, I_p (mA)		
Shunt Current, I_s (mA)		
Line Voltage, V_L (V)		
Location: Side (FR = Front, BK = Back, LT = Left, RT = Right, TP = Top, BT = Bottom)		
Maximum Dimension of Beam (L = large than 2 inches S = smaller than 2 inches)		
Section of Side (1-9; see coding guide on Location of Meter)		

Signature: ______________________ Date: ______________

Page ______ of ______21

Test No. ________

Card Type 7

Conditions That Produce 0.5 mR/hr at Locations of Maximum Emissions

	Picture Tube	Shunt Reg. Tube	Rectifier Tube	Defective Shunt
Victoreen 440 RF (mR/hr)				
Stoms Meter (units)				
Picture Voltage Vp (kV)				
Picture Current, I_p' (mA)				
Shunt Current, I_s (mA)				
Line Voltage, V_L (V)				
Location: Side (FR = Front BK = Back LT = Left RT = Right TP = Top BT = Bottom)				
Maximum Dimension of Beam (L = larger than 2 inches S = smaller than 2 inches)				
Section of Side (1-9; see coding guide on Location of Meter)				

Signature: ______________________________

IV. INSTRUMENTATION AND CALIBRATION

The following electrical instruments were utilized in the examination of each receiver:

Weston Model 904 A.C. Voltmeter
Simpson Model 1327 D.C. Milliammeters
Hallmark Model KVE Electrostatic Voltmeter
Victoreen Model 440 RF Survey Meter
Victoreen Model 440 RF/C Survey Meter
Stoms Survey Meter
Sorenson Model 1000S A.C. Voltage Regulator
Leader Electronics Corp. Model 388 Color Bar Pattern Generator
General Radio Variac

The ammeters, voltmeters and radiation detection instruments were calibrated by the Radiation Measurement and Calibration Branch of the Division of Electronic Products.

The Victoreen 440 RF Survey meters are designed to measure the radiation exposure rate of an X-ray beam by using an enclosed ion chamber. They were calibrated with a Victoreen Model 401 free air ion chamber over a range of 25 kev to 50 kev and half value layers of Aluminum from 0.77 mm to 3.90 mm. In addition, a Victoreen 440 RF/C survey meter was available for the tests performed on a limited number of receivers. This new model, calibrated by the manufacturer, is the only instrument available which conforms to the specifications of the performance standard (see Appendix A).

The DEP large area survey instrument, or Stoms Meter, employs an array of six Geiger-Mueller tubes (2). It is a photon counting instrument and its output is not proportional to exposure rate over the range of photon energies emitted by television receivers. Consequently, the Stoms meter is used to locate the areas on a particular receiver emitting large numbers of X-rays. However, the instrument can be calibrated at particular energies to give information regarding dose rate. Using a Victoreen 440 RF, it was found that a reading of 8000 scale units on the Stoms meter at an energy of 22 kev would roughly correspond to an emission rate of 0.5 mR/hr. During the in-plant TV survey the meters had been set so that readings of 4000 scale units at 22 kev had corresponded to 0.5 mR/hr. Finally, to assure that the radiation instruments maintained sensitivity, they were checked twice daily using a 109-Cd source.

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V. LIST OF RECEIVERS TESTED

Brand	Manufacturer	Chassis No.	Model No.	Serial No.
Admiral	Admiral	4H1273-13	3L3139	A432312
Admiral	Admiral	12H107311	8T331C	A458830
Andrea	Andrea	VCX-325-1	SPECTRA	302832
Coronado	Wells-Gardner	T381	G12K3800644	719537
Curtis Mathes	Curtis Mathes	C24-7	52M742	735336
Curtis Mathes	Nippon Electric		52M594	596618
Dumont	Dumont Emerson	C85	55C29	294109
Dumont	Dumont Emerson	C87	59T01W	317646
General Electric	General Electric	KE	M926BMP	0Z3E04016
Magnavox	Magnavox	T93801AB	1C6402	2348713
Motorola	Motorola	J20TS921D02	CT665EW	92271412
Muntz	TMA	9034	2481FP	28603
Muntz	TMA	9021-8	2181	2340
Muntz	TMA	9015-4	1581-2	60416
Olympic	Nippon Columbia	CT400	CT400	B017055
Olympic	Nippon Columbia	CT911	CT911	B018670
Packard Bell	Matsushita		CQ322	533971
Sears	Toshiba	56210523	4074	51667686
Setchell Carlson	Setchell Carlson	U812	3100	576492
Setchell Carlson	Setchell Carlson	U903B	9MC903B	581634
Setchell Carlson	Setchell Carlson	U806	2200	564584
Setchell Carlson	Setchell Carlson	U811	3000	576564

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VI. INDIVIDUAL RECEIVER REPORTS

Following are individual reports on each of the receivers tested. Each report contains receiver identification data, a table of maximum radiation measurements at 135 VAC line voltage, a table of radiation measurements under normal operating conditions, a table of radiation measurements corresponding to the phases of the performance standard, an analysis of the data collected, comments on the tests performed, and recommendations.

In using the tables, it should be noted that all radiation readings are recorded net of background. Also, under the receiver identification data the picture, rectifier, and shunt regulator tubes are listed as manufacturer and type. If the label on the tube was different from the manufacturer, it was so noted. In certain cases, the manufacturer of the tube was not known and does not appear on the data sheet.

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Report of Laboratory Tests on Admiral Model No. 3L3139

RECEIVER IDENTIFICATION DATA

Manufacturer:	Admiral	Cabinet Style:	Console
Brand Name:	Admiral	Cabinet Material:	Wood
Model Number:	3L3139	Picture Tube:	Admiral 25SP22
Chassis Number:	4H1273-13	Rectifier Tube:	GE 3BT2(labelled Admiral)
Serial Number:	A432312	Shunt Reg. Tube:	GE 6EL4(labelled Admiral)
Production Data:	June 1969	Recommended H.V.:	24.5 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	0.50	2.4
Stoms Meter (units)	11.0	50.0
Picture Voltage (kV)	30.5	36.0
Picture Current (mA)	0.88	0.18
Shunt Current (mA)	0.06	0.00
Source of Radiation	Picture tube	Picture tube
Location of Radiation	Front 4	Front 4

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	25.1
Picture Current (mA)	0.85
Shunt Current (mA)	0.41
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.05	0.20	1.20
Stoms Meter (units)	0.40	4.40	27.0
Picture Voltage (kV)	26.4	29.4	34.3
Picture Current (mA)	1.19	0.80	0.20
Shunt Current (mA)	0.42	0.05	0.00
Line Voltage (V)	130	130	130
Source of Radiation	Picture tube	Picture tube	Picture tube
Location of Radiation	Front 4	Front 4	Front 4

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Analysis of Data

In this report, Table I is a repeat of the measurements taken in the field. The radiation measurements taken during the in-plant survey were approximately the same as those above.

Table II shows the radiation emitted from the receiver under normal operating conditions. The data indicated negligible X-ray levels in this situation.

Table III included those radiation tests pertaining to the performance standard for television receivers. Column 1 refers to the first portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts line and all user controls adjusted so as to produce maximum radiation. Thus, the product tested met requirements for receivers to be manufactured subsequent to January 15, 1970.

Column 2 refers to the second portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts with the high voltage service control set at maximum and user controls adjusted to produce maximum radiation. Thus, the product tested would meet the standard for receivers to be manufactured subsequent to June 1, 1970.

Column 3 refers to the third portion of the standard. It was noted that X-ray emissions from the receiver were above 0.5 mR/hr with service and user controls adjusted for maximum emission and conditions identical to those which result from a component or circuit failure (i.e defective shunt regulator tube).

In this situation, the picture tube, the source of radiation, emitted X-rays in excess of 0.5 mR/hr as a result of an increase in high voltage to 34.3 kV. Thus, the product tested would not meet the standard for receivers to be manufactured subsequent to June 1, 1971.

Comments

With the defective shunt regulator tube inserted in the receiver, other areas of radiation were noted from positions over the entire surface of the set other than that tabulated. It was necessary to reduce the line voltage to 125 volts to achieve less than 0.5 mR/hr from the front of the receiver.

Recommendation

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from (a) maladjustment of service controls or/and (b) a defective shunt regulator tube. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them, (2) redesigning the receiver to eliminate the shunt regulator tube, (3) installing circuits to limit and control the high voltage applied to X-ray emitting parts even in the event of component or circuitry failure, or to accomplish this indirectly by regulating the input power supply voltage.

Report of Laboratory Tests on Admiral Model No. 8T331C

RECEIVER IDENTIFICATION DATA

Manufacturer: Admiral
Brand Name: Admiral
Model Number: 8T331C
Chassis Number: 12H107311
Serial Number: A458830
Production Data: July 1969

Cabinet Style: Portable
Cabinet Material: Metal
Picture Tube: 19HFP22(labelled Admiral)
Rectifier Tube: GE 3BT2(labelled Admiral)
Shunt Reg. Tube: None
Recommended H.V.: 26.0 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	8.10	
Stoms Meter (units)	71.0	
Picture Voltage (kV)	36.5	
Picture Current (mA)	0.17	
Shunt Current (mA)	N/A	
Source of Radiation	Picture tube	
Location of Radiation	Front 8	

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	16.8
Picture Current (mA)	1.94
Shunt Current (mA)	N/A
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.00	4.00	
Stoms Meter (units)	0.05	56.0	
Picture Voltage (kV)	24.5	34.9	
Picture Current (mA)	0.35	0.15	
Shunt Current (mA)	N/A	N/A	
Line Voltage (V)	130	130	
Source of Radiation	Picture tube	Picture tube	
Location of Radiation	Front 8	Front 8	

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Analysis of Data

In this report, Table I is a repeat of the measurements taken in the field. The radiation measurements taken during the in-plant survey were approximately the same as those above. The differences can be attributed to expected measurement inaccuracies.

Table II shows the radiation emitted from the receiver under normal operating conditions. The data indicated negligible X-ray levels in this situation.

Table III included those radiation tests pertaining to the performance standard for television receivers. Column 1 refers to the first portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts line and all user controls adjusted so as to produce maximum radiation. Thus, the product tested would meet requirements for receivers to be manufactured subsequent to January 15, 1970.

Column 2 refers to the second portion of the standard. It was noted that X-ray emissions from the picture tube, the source of the radiation, were far above 0.5 mR/hr at the maximum rated voltage of 130 volts with the high voltage service control set at maximum and user controls adjusted to produce maximum radiation. Thus, the product tested would not meet the standard for receivers to be manufactured subsequent to June 1, 1970.

Column 3 refers to the third portion of the standard. Since this receiver did not contain a shunt regulator tube, no tests were made applicable to defective individual components.

From the data presented, it is evident that the excessive radiation observed was due to extremely high voltages on the picture tube.

Comments

With the receiver set up for maximum emission from the picture tube, it was necessary to reduce the line voltage to 115 volts to obtain 0.5 mR/hr from the receiver.

Recommendations

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from maladjustment of service controls. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them or (2) installing circuits to limit and control the high voltage applied to X-ray emitting parts.

Report of Laboratory Tests on Andrea Model SPECTRA

RECEIVER IDENTIFICATION DATA

Manufacturer:	Andrea	Cabinet Style:	Console
Brand Name:	Andrea	Cabinet Material:	Wood
Model Number:	SPECTRA	Picture Tube:	Sylvania 25XP22
Chassis Number:	VCX-325-1	Rectifier Tube:	RCA 3A3A(labelled Andrea)
Serial Number:	302832	Shunt Reg. Tube:	Sylvania 6BK4C(labelled Andrea)
Production Date:	May 1969	Recommended H.V.:	25.0 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	0.90	3.00
Stoms Meter (units)	20.0	49.0
Picture Voltage (kV)	34.5	37.9
Picture Current (mA)	0.64	0.40
Shunt Current (mA)	0.29	0.00
Source of Radiation	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	24.6
Picture Current (mA)	1.17
Shunt Current (mA)	0.20
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.00	0.40	1.50
Stoms Meter (units)	0.05	10.0	32.0
Picture Voltage (kV)	27.6	33.6	36.4
Picture Current (mA)	0.70	0.46	0.41
Shunt Current (mA)	0.76	0.40	0.00
Line Voltage (V)	130	130	130
Source of Radiation	Picture tube	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5	Front 5

Analysis of Data

In this report, Table I is a repeat of the measurements taken in the field. The radiation measurements taken during the field survey differed in magnitude and location from those taken in the laboratory. The conflicting data can be attributed to the fact that when the set was tested in the field, it contained a different shunt regulator tube which appeared to be the source of radiation. The tube had been replaced before arriving at the laboratory.

Table II shows the radiation emitted from the receiver under normal operating conditions. The data indicated negligible X-ray levels in this situation.

Table III included those radiation tests pertaining to the performance standard for television receivers. Column I refers to the first portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts. Thus, the product tested would meet the requirements for receivers to be manufactured subsequent to January 15, 1970.

Column 2 refers to the second portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts with the high voltage service control set at maximum and user controls adjusted to produce maximum radiation. Thus, the product tested would meet the standard for receivers to be manufactured subsequent to June 1, 1970.

Column 3 refers to the third portion of the standard. It was noted that X-ray emissions from the receiver were above 0.5 mR/hr with service and user controls adjusted for maximum emission and conditions identical to those which result from a component or circuit failure (i.e., a defective shunt regulator tube).

In this situation, the picture tube, the source of radiation, emitted X-rays in excess of 0.5 mR/hr as a result of an increase in high voltage to 36.0 kV. Thus, the product tested would not meet standards for receivers to be manufactured subsequent to June 1, 1971.

Comment

With the defective shunt regulator tube inserted in the receiver, other areas of radiation were noted from positions over the entire surface of the set other than that tabulated. It was necessary to reduce the line voltage of 122 volts to achieve less than 0.5 mR/hr from the front of the set.

Recommendations

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from (a) maladjustment of service controls or/and (b) a defective shunt regulator tube. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them, (2) redesigning the receiver to eliminate the shunt regulator tube, (3) installing circuits to limit and control the high voltage applied to X-ray emitting parts even in the event of component or circuitry failure, or to accomplish this indirectly by regulating the input power supply voltage.

Report of Laboratory Tests on Coronado Model No. G12K3800644

RECEIVER IDENTIFICATION DATA

Manufacturer: Wells-Gardner
Brand Name: Coronado
Model Number: G12K3800644
Chassis Number: T381
Serial Number: 719537
Production Date: May 1969

Cabinet Style: Console
Cabinet Material: Wood
Picture Tube: National Video 25ZP22 (labelled Wells-Gardner)
Rectifier Tube: GE 3DB3
Shunt Reg. Tube: Hitachi 6BK4B
Recommended H.V.: 25.0 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	0.50	4.00
Stoms Meter (units)	13.6	53.0
Picture Voltage (kV)	30.0	34.7
Picture Current (mA)	0.81	0.37
Shunt Current (mA)	0.37	0.00
Source of Radiation	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	24.2
Picture Current (mA)	1.05
Shunt Current (mA)	0.30
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.10	0.20	1.50
Stoms Meter (units)	0.60	4.20	33.0
Picture Voltage (kV)	26.6	28.7	33.8
Picture Current (mA)	1.05	0.67	0.23
Shunt Current (mA)	0.49	0.15	0.00
Line Voltage (V)	130	130	130
Source of Radiation	Picture tube	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5	Front 5

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Analysis of Data

In this report, Table I is a repeat of the measurements taken in the field. The radiation measurements taken during the in-plant survey were approximately the same as those above. The differences can be attributed to expected measurement discrepancies and higher voltages in the field.

Table II shows the radiation emitted from the receiver under normal operating conditions. The data indicate negligible X-ray levels in this situation.

Table III included those radiation tests pertaining to the performance standard for television receivers. Column 1 refers to the first portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts line and all user controls adjusted so as to produce maximum radiation. Thus, the product tested would meet requirements for receivers to be manufactured subsequent to January 15, 1970.

Column 2 refers to the second portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts with the high voltage service control set at a maximum and user controls adjusted to produce maximum radiation. Thus, the product tested would meet the standard for receivers to be manufactured subsequent to June 1, 1970.

Column 3 refers to the third portion of the standard. It was noted that X-ray emissions from the receiver were above 0.5 mR/hr with service and user controls adjusted for maximum emission and conditions identical to those which result from a component or circuit failure (i.e., a defective shunt regulator tube).

In this situation, the picture tube, the source of radiation, emitted X-rays in excess of 0.5 mR/hr as a result of an increase in high voltage to 33.8 kV. Thus, the product tested would not meet the standard for receivers to be manufactured subsequent to June 1, 1971.

Comment

It was necessary to reduce the line voltage to 121 volts to achieve less than 0.5 mR/hr from the front of the receiver with a defective shunt regulator tube in the set.

Recommendation

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from (a) maladjustment of service controls or/and (b) a defective shunt regulator tube. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them, (2) redesigning the receiver to eliminate the shunt regulator tube, (3) installing circuits to limit and control the high voltage applied to X-ray emitting parts even in the event of component or circuitry failure, or to accomplish this indirectly by regulating the input power supply voltage.

Report of Laboratory Tests on Curtis Mathes Model No. 52M742

RECEIVER IDENTIFICATION DATA

Manufacturer:	Curtis Mathes	Picture Tube:	National Video 25AFP22
Brand Name:	Curtis Mathes		(labelled Curtis Mathes)
Model Number:	52M742	Rectifier Tube:	Sylvania 3A3A
Chassis Number:	C24-7		(labelled Curtis Mathes)
Serial Number:	735336	Shunt Reg. Tube	Tung Sol 6BK4B
Production Date:	April 1969		(labelled Curtis Mathes)
Cabinet Style:	Console	Recommended H.V.:	25.0 kV
Cabinet Material:	Wood		

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	2.00	2.10
Stoms Meter (units)	26.0	46.0
Picture Voltage (kV)	31.5	38.4
Picture Current (mA)	0.05	0.18
Shunt Current (mA)	0.96	0.00
Source of Radiation	Shunt regulator tube	Picture tube
Location of Radiation	Left 8	Front 5

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	24.2
Picture Current (mA)	1.32
Shunt Current (mA)	0.00
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.05	0.90	0.90
Stoms Meter (units)	1.70	14.0	27.0
Picture Voltage (kV)	27.1	30.2	36.4
Picture Current (mA)	0.06	0.05	0.16
Shunt Current (mA)	1.30	0.99	0.00
Line Voltage (V)	130	130	130
Source of Radiation	Shunt Reg. tube	Shunt Reg. tube	Picture tube
Location of Radiation	Left 8	Left 8	Front 5

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Analysis of Data

When the field tests were repeated in the laboratory, the lab radiation readings were lower than the field measurements. Table I presents the laboratory data taken under the conditions of the field tests (135 VAC line voltage). These differences are within reason considering some of the problems that could have occurred in the field. It should be noted that the Victoreen 440 RF may be questioned as a usable survey meter for measuring radiation from a shunt regulator tube. However, the radiation observed from this shunt regulator tube was of large enough area to essentially fill the entire end window of the 440 RF. This is confirmed by the fact that the Stoms meter reading of 26.0 (Table I, Column 1) at the observed high voltage is approximately equal to the 2.0 mR/hr measured with the 440 RF.

By referring to the normal operating conditions data (Table II) which simulates proper operation in the home, it is evident that this receiver did not produce any measurable radiation when operated in this ideal state.

Column 1 of Table III lists measurements that refer to the first phase of the standard that will go into effect January 15, 1970. It is evident that the low radiation readings (0.05 mR/hr on the 440 RF and 1.70 on the Stoms meter) are well within the standard of 0.5 mR/hr. To obtain these readings, only user controls were adjusted for maximum emission.

Column 2, Table III refers to the second phase of the standard in which both user and service controls may be adjusted for maximum emission. This phase is scheduled to go into effect June 1, 1970. With the high voltage control set to its maximum position, readings of 0.9 mR/hr on the 440 RF and 14.0 on the Stoms meter indicate that this receiver, were it manufactured after June 1, 1970, would not comply with the standard of 0.5 mR/hr. Readings taken with the Victoreen 440 RF/C (which is a more applicable meter to measure radiation from a shunt regulator tube) confirmed the measurements taken with the 440 RF.

Column 3, Table III refers to the third phase of the standard in which measurements can be made with component and/or circuit failures that maximize X-radiation emission using any of the above forementioned controls. For this test, a defective shunt regulator was substituted for the original tube and all controls were adjusted for maximum emission. The value of 0.9 mR/hr measured shows that this receiver would not comply with this phase of the standard if it were manufactured after June 1, 1971.

The principal X-ray emitting component of the receiver with all original parts in the set was the shunt regulator tube. During the course of the tests, it was proved conclusively that this was the component that was emitting excessive radiation. For proof, a shunt regulator tube that was known to emit a minimal amount of radiation (type GE 6EL4A which has 50% lead in the glass) was placed in the receiver and only insignificant radiation was observed (zero on the 440 RF and 1.0 on the Stoms) with the same control settings. With the defective shunt regulator tube in the receiver, the picture tube was the emitter of the excessive radiation under maximum settings.

The radiation from the shunt regulator tube was due to the tube itself and the high voltage of 30.2 kV (Table III, Column 1). It is felt that this particular tube is the main problem. The radiation from the picture tube with the defective shunt regulator tube in the receiver was due solely to the excessive high voltage, 36.4 kV. With no regulating tube in the circuit, the voltage was allowed to climb to this very high value.

Comments

The only comment other than the items mentioned in the analysis of data is that the line voltage had to be reduced to 125.5 VAC to reduce the radiation from the shunt regulator tube to 0.5 mR/hr. To reduce the radiation from the picture tube (defective shunt in set) to 0.5 mR/hr, the line voltage had to be reduced to 126 VAC.

Recommendations

The shunt regulator tube emission problem may be solved at least in one of three ways:

(1) Replace the original component with a non-interchangeable tube that is designed not to emit excessive radiation, and correct all diagrams and instructions accordingly.

(2) Place additional permanent shielding around the tube.

(3) Introduce a voltage control circuit in the receiver to limit the voltage applied to the X-ray emitting parts.

To eliminate the radiation possibility from the picture tube when the shunt regulator tube goes bad, a voltage control circuit is necessary that will function even though the regulator fails. This type of control circuit would also reduce the shunt regulator tube radiation problems.

Report of Laboratory Tests on Curtis Mathes Model No. 52M594

RECEIVER IDENTIFICATION DATA

Manufacturer: Nippon Electric
Brand Name: Curtis Mathes
Model Number: 52M594
Chassis Number: N A
Serial Number: 596618
Production Date: July 1969
Cabinet Style: Portable

Cabinet Material: Plastic
Picture Tube: Toshiba 16CYP22 (labelled Curtis Mathes)
Rectifier Tube: Toshiba 3A3 (labelled Curtis Mathes)
Shunt Reg. Tube: None
Recommended H.V.: 20.0 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	2.90	
Stoms Meter (units)	34.0	
Picture Voltage (kV)	25.2	
Picture Current (mA)	0.37	
Shunt Current (mA)	N/A	
Source of Radiation	Picture tube	
Location of Radiation	Back 6	

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	19.4
Picture Current (mA)	0.06
Shunt Current (mA)	N/A
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.00	1.55	
Stoms Meter (units)	0.10	20.0	
Picture Voltage (kV)	20.5	24.5	
Picture Current (mA)	0.08	0.30	
Shunt Current (mA)	N/A	N/A	
Line Voltage (V)	130	130	
Source of Radiation	Picture tube	Picture tube	
Location of Radiation	Back 6	Back 6	

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Analysis of Data

In the process of analyzing the data taken, it will be helpful to refer to the comments section of this report for additional information and data.

The measurements taken in the field and the repeat of these measurements in the laboratory are in close agreement. Table I presents the data taken in the laboratory that corresponds to the field survey data.

By referring to the normal operating conditions data (Table II) which simulated proper operation in the home, it is observed that there was no measurable radiation in this ideal state.

The measurements that refer to the first phase of the standard, which allows adjustment of only user controls for maximum emission, are presented in Table III, Column 1. The negligible readings are well within the limits of this phase of the standard scheduled to go into effect January 15, 1970.

The data corresponding to the second phase of the standard which permits adjustment of both user and service controls for maximum emission are presented in Table III, Column 2. With the high voltage control set to its maximum position, the observed X-radiation emission of 1.55 mR/hr on the 440 RF clearly indicates that this receiver, were it manufactured after June 1, 1970, would not comply with the standard of 0.5 mR/hr.

Since this receiver did not have a shunt regulator tube, there is no data representative of the third phase of the standard, which allows for measurements to be made with component and/or circuit failures that maximize X-radiation emission using both user and service controls.

Under all of the laboratory tests, the excessive radiation was being emitted from the neck on the picture tube. Even though the high voltages measured on the picture tube are sufficient to produce X-radiation, it is felt that this foreign made tube is partially at fault. The picture tube has very little current capacity (and consequently a dim picture) unless the high voltage control is turned to its maximum position, which would be the tendency in order to increase picture brightness. When this happens, the tube emits radiation in excess of the standard.

Comments

When this receiver was first tested in the laboratory, the manufacturer's recommended high voltage setting was not available. However, to get what was considered a normal picture on the receiver at 120 VAC line voltage, the high voltage control had to be set to its maximum position. At this setting, the high voltage was measured to be 23.7 kV at minimum brightness. Under these conditions, measurements of 0.45 mR/hr under normal operating conditions (120 VAC line voltage) and 1.55 mR/hr under the terms of the first phase of the standard were obtained.

After testing the receiver, the recommended high voltage at minimum brightness was requested from the manufacturer. Upon receiving this information (20.0 kV at minimum brightness and 120 VAC line voltage), the previous measurements were then repeated using this new value. These readings are presented in Tables II and III. It should be noted that these readings were taken with a dim, but viewable, picture.

Recommendations

If the manufacturer (or distributor) continues to use this picture tube, he should have some sort of circuit in the receiver that will limit the amount of voltage produced. In addition, it is felt that due to the low value of high voltage which produced excessive radiation, the Product Testing and Evaluation Branch should purchase a replacement tube for this receiver from a manufacturer other than Toshiba in order to compare its emission capability at these low voltages.

Report of Laboratory Tests on Dumont Model No. 55C29

RECEIVER IDENTIFICATION DATA

Manufacturer:	Dumont Emerson	Picture Tube:	RCA 25XP22 (labelled Dumont)
Brand Name:	Dumont		
Model Number:	55C29	Rectifier Tube:	Sylvania 3CU3 (labelled Dumont)
Chassis Number:	C85		
Serial Number:	294109	Shunt Reg. Tube:	Sylvania 6BK4B (labelled Dumont)
Production Date:	June 1969		
Cabinet Style:	Console	Recommended H.V.:	24.0 kV
Cabinet Material:	Wood		

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	2.60	8.60
Stoms Meter (units)	48.0	96.0
Picture Voltage (kV)	35.0	40.0
Picture Current (mA)	0.26	0.17
Shunt Current (mA)	0.00	0.00
Source of Radiation	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	24.9
Picture Current (mA)	0.63
Shunt Current (mA)	0.62
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.00	1.80	2.20
Stoms Meter (units)	0.25	34.00	45.00
Picture Voltage (kV)	26.2	33.6	36.5
Picture Current (mA)	0.87	0.29	0.12
Shunt Current (mA)	0.67	0.00	0.00
Line Voltage (V)	130	130	130
Source of Radiation	Picture tube	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5	Front 5

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Analysis of Data

There was a large discrepancy between radiation and high voltage readings taken in the field and in the laboratory. Table I presents the data taken in the laboratory that corresponds to the field survey data. The laboratory data is more significant than the field data because the field surveyors encountered arcing and corona problems due to poor connectors. In the laboratory, these problems were almost entirely eliminated and the picture tube voltage rose to excessive and dangerous levels. Consequently, the radiation readings were higher.

By referring to the normal operating conditions data (Table II) which simulates proper operation in the home, it is evident that this receiver did not produce any measurable radiation when operated in this ideal state.

The measurements that refer to the first phase of the standard, which allows adjustment of only user controls for maximum emission, are presented in Table III, Column 1. The readings were insignificant, indicating that this receiver would meet the January 15, 1970, phase of the standard.

The data corresponding to the second phase of the standard, which permits adjustment of both user and service controls for maximum emission, are present in Table III, Column 2. With the high voltage control set to its maximum position, the observed X-radiation emission of 1.8 mR/hr on the 440 RF indicate that this receiver, were it manufactured after June 1, 1970, would not comply with the standard of 0.5 mR/hr.

The data representing tests performed under the third phase of the standard is presented in Table III, Column 3. This phase allows for measurements to be made with component and/or circuit failures that maximize X-radiation emission using both user and service controls. For this test, a defective shunt regulator tube was substituted for the original tube and the controls were adjusted for maximum emission. The value of 2.2 mR/hr measured shows that this receiver would not comply with this phase of the standard if it were manufactured after June 1, 1971.

Under all the laboratory tests, the excessive radiation was being emitted from the front of the picture tube. The radiation from the picture tube was due to the abnormally high voltages.

Comments

At minimum brightness with a defective shunt regulator tube in the circuit (at 135 VAC line), the high voltage on the picture tube continually rose to a maximum value and then started dropping as arcing and corona developed. It was very hard to take a meaningful reading, however, 40 kV seemed to be the maximum value. At this setting, Stoms meter readings of 23,000 units were measured from the top and left side of the receiver from the picture tube.

During the typical operating conditions test, the set was regulating fairly well until H.V. setting 4 was reached. Then the regulation varied 3-5 kV depending on the brightness control. It was decided to set the brightness control for a good picture and leave it for the following settings. It turned out that the setting resulted in no current through the shunt regulator tube. This accounts for the discrepancy between the maximum high voltage observed during the typical operating conditions and the voltage measured at maximum radiation emission. The voltage at maximum emission was higher because the brightness control was set at a lower level and the poor regulation of the set allowed the voltage to increase.

With original components in the receiver, it was necessary to reduce the line voltage to 125 VAC to reduce the radiation to 0.5 mR/hr. With the defective shunt regulator tube in the receiver, it was necessary to reduce the line voltage to 123 VAC to reduce the radiation to 0.5 mR/hr.

Recommendations

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from (a) maladjustment of service controls or/and (b) a defective shunt regulator tube. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them, (2) redesigning the receiver to eliminate the shunt regulator tube, (3) installing circuits to limit and control the high voltage applied to X-ray emitting parts even in the event of component or circuitry failure, or to accomplish this indirectly by regulating the input power supply voltage.

Report of Laboratory Tests on Dumont Model No. 59T01W

RECEIVER IDENTIFICATION DATA

Manufacturer:	Dumont Emerson	Cabinet Material:	Wood
Brand Name:	Dumont	Picture Tube:	Nippon Columbia 490BCB22 (labelled Dumont)
Model Number:	59T01W		
Chassis Number:	C87	Rectifier Tube:	GE 3CN3A(labelled Dumont)
Serial Number:	317646	Shunt Reg. Tube:	None
Production Date:	March 1969	Recommended H.V.:	24.0 kV
Cabinet Style:	Console		

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	1.40	
Stoms Meter (units)	19.0	
Picture Voltage (kV)	28.9	
Picture Current (mA)	0.35	
Shunt Current (mA)	N/A	
Source of Radiation	Picture tube	
Location of Radiation	Top 5	

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	21.1
Picture Current (mA)	0.44
Shunt Current (mA)	N/A
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.15	0.60	
Stoms Meter (units)	0.90	10.0	
Picture Voltage (kV)	24.8	27.5	
Picture Current (mA)	0.18	0.23	
Shunt Current (mA)	N/A	N/A	
Line Voltage (V)	130	130	
Source of Radiation	Picture tube	Picture tube	
Location of Radiation	Top 5	Back 2	

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Analysis of Data

Laboratory testing of this receiver has produced radiation data which corresponds very closely with that data gathered during the in-plant survey in July. Table I contains the laboratory results obtained under set-up conditions identical to the field survey.

Table II summarizes the results obtained when the receiver was operated under the manufacturer's set-up recommendations. No radiation was detectable under these conditions.

Table III consists of two columns of data relevant to the standard. The first column shows measurements under conditions of user control adjustments for maximum emission. Since 0.15 mR/hr is within the standard, no action is necessary. The second column is maximum emission data gathered under conditions of service and user control adjustment. As of June 1, 1970, if a similar set were manufactured, it would exceed the maximum level of 0.5 mR/hr and corrective procedures would have to be undertaken.

In all cases where emission was observed, it was emanating from the picture tube. The area of maximum emission was that defined as the area where the anode lead connects onto the picture tube.

From the data presented, it is concluded that the cause of radiation is excessive high voltage on the picture tube.

Comments

Looking over the tables, it is observed that the position of maximum emission alternated between top 5 and back 2. The source of radiation did not change, it was always from the anode connection. It was decided that since the needle on the 440 RF had a tendency to stick when the instrument was placed on its sensitive face on the top of the receiver, not to use this reading but rather to locate the meter at another position. A maximum reading was obtained when the 440 RF was positioned at location Back 2. This location was used.

In surveying this unit, radiation was not limited to the location described above. It was found all around the funnel of the picture tube.

As an evaluation of the effect of line voltage on radiation emission, the receiver was set up under the conditions of the June 1, 1970, standard criteria. The line voltage was then lowered to the point at which 0.5 mR/hr was recorded. The value at which this occurred was 129 VAC.

Recommendations

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from maladjustment of service controls. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them or (2) installing circuits to limit and control the high voltage applied to X-ray emitting parts.

Report of Laboratory Tests on General Electric Model No. M926EMP

RECEIVER IDENTIFICATION DATA

Manufacturer:	General Electric	Cabinet Style:	Console
Brand Name:	General Electric	Cabinet Material:	Wood
Model Number:	M926EMP	Picture Tube:	25ALP22 (labelled GE)
Chassis Number:	KE	Rectifier Tube:	GE 3CN3A
Serial Number:	0Z3E04016	Shunt Reg. Tube:	GE 6LJ6
Production Date:	January 1969	Recommended H.V.:	25.0 kV

TABLE 1: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	0.90	2.20
Stoms Meter (units)	18.0	38.0
Picture Voltage (kV)	31.3	34.8
Picture Current (mA)	0.86	0.40
Shunt Current (mA)	0.37	0.00
Source of Radiation	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	24.9
Picture Current (mA)	0.62
Shunt Current (mA)	0.63
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.00	0.30	0.90
Stoms Meter (units)	0.30	6.50	18.00
Picture Voltage (kV)	26.6	29.7	33.0
Picture Current (mA)	1.00	1.03	0.35
Shunt Current (mA)	0.42	0.10	0.00
Line Voltage (V)	130	130	130
Source of Radiation	Picture tube	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5	Front 5

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Analysis of Data

In this report, table I is a repeat of the measurements taken in the field. The radiation measurements taken during the in-plant survey were approximately the same as those above.

Table II shows the radiation emitted from the receiver under normal operating conditions. The data indicated negligible X-ray levels in this situation.

Table III included those radiation tests pertaining to the performance standard for television receivers. Column 1 refers to the first portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts line and all user controls adjusted so as to produce maximum radiation. Thus, the product tested would meet the requirements for receivers to be manufactured subsequent to January 15, 1970.

Column 2 refers to the second portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts with the high voltage service control set at maximum and user controls adjusted to produce maximum radiation. Thus, the product tested would meet the standard for receivers to be manufactured subsequent to June 1, 1970.

Column 3 refers to the third portion of the standard. It was noted that X-ray emissions from the receiver were above 0.5 mR/hr with service and user controls adjusted for maximum emission and conditions identical to those which result from a component or circuit failure (i.e., a defective shunt regulator tube). In this situation, the picture tube, the source of radiation, emitted X-rays in excess of 0.5 mR/hr as a result of an increase in high voltage to 33.0 kV. Thus, the product tested would not meet the standard for receivers to be manufactured subsequent to June 1, 1971.

Comments

With the defective shunt regulator tube inserted in the receiver, other areas of radiation were noted from positions over the entire surface of the set other than that tabulated above. It was necessary to reduce the line voltage to 126 volts to achieve less than 0.5 mR/hr from the front of the receiver.

Recommendation

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from (a) maladjustment of service controls or/and (b) a defective shunt regulator tube. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them, (2) redesigning the receiver to eliminate the shunt regulator tube, (3) installing circuits to limit and control the high voltage applied to X-ray emitting parts even in the event of component or circuitry failure, or to accomplish this indirectly by regulating the input power supply voltage.

Report of Laboratory Tests on Magnavox Model No. 1C6402

RECEIVER IDENTIFICATION DATA

Manufacturer:	Magnavox	Cabinet Material:	Wood
Brand Name:	Magnavox	Picture Tube:	RCA 21GVP22
Model Number:	1C6402	Rectifier Tube:	Sylvania 3CU3A
Chassis Number:	T93801 AB		(labelled Magnavox)
Serial Number:	2348713	Shunt Reg. Tube:	Sylvania 6BK4C
Production Date:	July 1969		(labelled Magnavox)
Cabinet Style:	Console	Recommended H.V.:	25.0 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	4.90	5.10
Stoms Meter (units)	56.0	59.0
Picture Voltage (kV)	33.6	34.5
Picture Current (mA)	0.40	0.24
Shunt Current (mA)	0.00	0.00
Source of Radiation	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	25.0
Picture Current (mA)	0.50
Shunt Current (mA)	0.40
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.10	2.30	2.60
Stoms Meter (units)	1.40	32.00	34.00
Picture Voltage (kV)	27.0	32.1	33.5
Picture Current (mA)	0.88	0.38	0.18
Shunt Current (mA)	0.20	0.00	0.00
Line Voltage (V)	130	130	130
Source of Radiation	Picture tube	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5	Front 5

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Analysis of Data

Under the maximum conditions test in the field, the surveyors could increase the line voltage to only 132 VAC before arcing developed. Due to this, the data in Table I cannot be compared with the field data; however, higher values, as expected were found at the higher line voltage of 135 VAC.

Table II summarizes the results obtained when the receiver was operated under the manufacturer's set-up recommendations. No radiation was detectable under these conditions.

Table III consists of three columns of data relevant to the standard. The first column shows measurements under conditions of user control adjustment for maximum emission. Since 0.10 mR/hr is within the standard, no action is necessary. The second column is maximum emission data gathered under conditions of service and user control adjustments. As of June 1, 1970, if a similar set was manufactured, it would exceed the maximum allowable level and corrective procedures would have to be undertaken. The third column, at which the highest emission rate was obtained, 2.6 mR/hr, illustrates that part of the standard which covers circuit failures. This problem will require correction on sets produced after June 1, 1971.

In all cases where emission was observed, the maximum emission rate was found at the front center of the picture tube.

From the data presented, it is concluded that the cause of radiation is excessive high voltage on the picture tube.

Comments

The problem of arcing when the line was increased above 132 volts in the field did not occur in the laboratory testing. There are two possible causes: the humidity could have been high and therefore the set was not dried out; or, connections in the field with sharp edges increased the probability of arcing.

At a point during the testing, the receiver shut down. The cause was a lead capacitor in the input filter.

When the high voltage control was turned up, a point was reached at which the shunt regulator tube ceased to function; therefore, the high voltage regulation was absent at this time and as the brightness was varied a large voltage swing was therefore observed.

At normal conditions, the picture was not very bright even though the CRT bias was at its maximum position.

As an evaluation of the effect of line voltage on radiation emission, the receiver was set up under the conditions of the June 1, 1970, standard criteria. The line voltage was then lowered to the point at which 0.5 mR/hr was recorded. The value at which this occurred was 121 VAC. Similarly, corresponding to the June 1, 1979 portion, with the defective shunt regulator tube, the line voltage had to be lowered to 120 VAC to reach 0.5 mR/hr.

Recommendations

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from (a) maladjustment of service controls or/ and (b) a defective shunt regulator tube. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them, (2) redesigning the receiver to eliminate the shunt regulator tube, (3) installing circuits to limit and control the high voltage applied to X-ray emitting parts even in the event of component or circuitry failure, or to accomplish this indirectly by regulating the input power supply voltage.

Report of Laboratory Tests on Motorola Model No. CT665EW

RECEIVER IDENTIFICATION DATA

Manufacturer:	Motorola	Cabinet Material:	Metal
Brand Name:	Motorola	Picture Tube:	Motorola 21GWP22 (labelled Motorola)
Model Number:	CT665EW		
Chassis Number:	J20TS921D03	Rectifier Tube:	GE 3BT2 (labelled Motorola)
Serial Number:	92271412		
Production Date:	August 1969	Shunt Reg. Tube:	None
Cabinet Style:	Portable	Recommended H.V.:	27.0 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	0.10	
Stoms Meter (units)	1.60	
Picture Voltage (kV)	30.7	
Picture Current (mA)	0.30	
Shunt Current (mA)	N/A	
Source of Radiation	Picture tube	
Location of Radiation	Front 4	

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	23.1
Picture Current (mA)	1.00
Shunt Current (mA)	N/A
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.00	0.00	
Stoms Meter (units)	0.10	0.35	
Picture Voltage (kV)	27.7	29.5	
Picture Current (mA)	0.46	0.25	
Shunt Current (mA)	N/A	N/A	
Line Voltage (V)	130	130	
Source of Radiation	Picture tube	Picture tube	
Location of Radiation	Front 4	Front 4	

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Analysis of Data

Under the maximum conditions test in the field, the surveyors reported a value of 0.5 mR/hr. Referring to Table I, it can be seen that the receiver tested in the lab under the same conditions produced a level of emission equal to 0.1 mR/hr. The reason these data do not correspond may be that the same model, but not the same receiver, was tested.

Table II summarizes the results obtained when the receiver was operated under manufacturers set-up conditions. No radiation was detectable under these conditions.

Table III consists of two columns of data relevant to the standard. The first column shows measurements under conditions of user control adjustments for maximum emission. This receiver was well within the standard. The second column is maximum emission data gathered under conditions of service and user control adjustments. Again, the receiver complied with the standard.

Radiation emission was very low and the only identificable source was the front left face of the picture tube.

Comments

Even though the set tested in the field showed more radiation than the one tested in the lab, it is doubtful that it would fail to comply with all phases of the standard which tests at 130 VAC line which is 5 volts lower than that of the field data. Based on these two sets of data, it appears that this chassis complies with the standard.

Recommendations

We recommend that the manufacturer be informed that our tests found that this receiver complies with the first two phases of the standard. No tests were made applicable to defective individual components or circuit failures.

Report of Laboratory Tests on
Muntz Model No. 2481FP

RECEIVER IDENTIFICATION DATA

Manufacturer:	TV Manufacturers of America	Cabinet Style:	Console
		Cabinet Material:	Wood
Brand Name:	Muntz	Picture Tube:	RCA H-22KP22
Model Number:	2481FP	Rectifier Tube:	RCA 3A3A
Chassis Number:	9034	Shunt Reg. Tube:	RCA 6BK4B
Serial Number:	28603	Recommended H.V.:	25.0 kV
Production Date:	April 1969		

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	0.50	3.20
Stoms Meter (units)	13.0	64.0
Picture Voltage (kV)	30.2	34.1
Picture Current (mA)	0.64	0.95
Shunt Current (mA)	0.40	0.00
Source of Radiation	Picture tube	Picture tube
Location of Radiation	Left 6	Front 5

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	24.6
Picture Current (mA)	1.00
Shunt Current (mA)	0.17
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.00	0.25	2.90
Stoms Meter (units)	0.50	8.20	47.0
Picture Voltage (kV)	27.2	29.4	33.0
Picture Current (mA)	0.76	0.75	0.92
Shunt Current (mA)	0.65	0.45	0.00
Line Voltage (V)	130	130	130
Source of Radiation	Picture tube	Picture tube	Picture tube
Location of Radiation	Left 6	Front 5	Front 5

Analysis of Data

In this report, Table I is a repeat of the measurements taken in the field. The radiation measurements taken during the in-plant survey were approximately the same as those above. The higher radiation in the field can be attributed to different picture tube voltage and current readings. See comments section.

Table II shows the radiation emitted from the receiver under normal operating conditions. The data indicates negligible X-ray levels in this situation.

Table III included those radiation tests pertaining to the performance standard for television receivers. Column 1 refers to the first portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts line and all user controls adjusted so as to produce maximum radiation. Thus, the product tested would meet the requirements for receivers to be manufactured subsequent to January 15, 1970.

Column 2 refers to the second portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts with the high voltage service control set at maximum and user controls adjusted to produce maximum radiation. Thus, the product tested would meet the standard for receivers to be manufactured subsequent to June 1, 1970.

Column 3 refers to the third portion of the standard. It is noted that X-ray emission from the receiver was far above 0.5 mR/hr with service and user controls adjusted for maximum emission and conditions identical to those which result from a component or circuit failure (i.e., defective shunt regulator tube).

In this situation, the picture tube, the source of radiation, emitted 2.9 mR/hr as a result of an increase in high voltage to 33 kV. Thus, the product tested would not meet the standard for receivers to be manufactured subsequent to June 1, 1971.

Comments

With the defective shunt inserted in the receiver, other areas of radiation were noted from positions over the entire surface of the set other than that tabulated above. Moreover, this test was not able to be completed due to continuous arcing in the high voltage cage.

In the TMA company log book, the surveyors noted that they had to tape the shunt regulator anode cap and the fly-back transformer to prevent arcing and thus have full range over the brightness control. During the lab test, it was felt that this action of taping was not necessary because it was a modification to the receiver and nothing more could be learned from the receiver. It was evident that the excessive high voltage was the cause of the radiation emission. The values in Table I were obtained just before arcing started.

Finally, it was necessary to reduce the line voltage to 116.5 volts to obtain 0.5 mR/hr from the receiver. Thus, this set will emit 0.5 mR/hr under normal operating conditions with the insertion of the defective shunt regulator tube.

Recommendations

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from (a) maladjustment of service controls or/and (b) a defective shunt regulator tube. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them, (2) redesigning the receiver to eliminate the shunt regulator tube, (3) installing circuits to limit and control the high voltage applied to X-ray emitting parts even in the event of component or circuitry failure, or to accomplish this indirectly by regulating the input power supply voltage.

Report of Laboratory Tests on Muntz Model No. 2181

RECEIVER IDENTIFICATION DATA

Manufacturer:	TV Manufacturers of America	Cabinet Style:	Console
		Cabinet Material:	Wood
Brand Name:	Muntz	Picture Tube:	Westinghouse 22WP22
Model Number:	2181	Rectifier Tube:	RCA 3A3A
Chassis Number:	9021-8	Shunt Reg. Tube:	GE 6EL4A
Serial Number:	2340	Recommended H.V.:	25.0 kV
Production Date:	April 1969		

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	0.20	10.60
Stoms Meter (units)	5.50	70.0
Picture Voltage (kV)	27.0	38.3
Picture Current (mA)	1.41	0.25
Shunt Current (mA)	0.14	0.00
Source of Radiation	Picture tube	Picture tube
Location of Radiation	Back 3	Front 5

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.20
Picture Voltage (kV)	24.0
Picture Current (mA)	1.14
Shunt Current (mA)	0.24
Line Voltage (V)	120
Source of Radiation	Picture tube
Location of Radiation	Back 1

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.25	0.14	5.40
Stoms Meter (units)	2.50	0.90	48.0
Picture Voltage (kV)	26.5	26.5	37.5
Picture Current (mA)	1.22	0.53	0.16
Shunt Current (mA)	0.25	0.75	0.00
Line Voltage (V)	130	130	130
Source of Radiation	Picture tube	Picture tube	Picture tube
Location of Radiation	Back 3	Back 3	Front 5

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Analysis of Data

Laboratory testing of this receiver has produced radiation data which corresponds very closely with that data gathered during the in-plant survey in July. Table I is the laboratory results obtained under conditions identical to the field survey.

Table II summarizes the results obtained when the receiver was operated under the manufacturer's set-up recommendations. A low emission rate was detected under these conditions.

Table III consists of three columns of data relevant to the standard. The first column shows measurements under conditions of user control adjustments for maximum emission. Since 0.25 mR/hr is within the standard, no action is necessary. The second column is maximum emission data gathered under conditions of service and user control adjustment. This set also meets requirements applied to the second phase of the standard. The third column, at which the highest emission rate was obtained, 5.4 mR/hr, shows noncompliance of the receiver with that part of the standard which covers circuit and component failures. This problem will require corrective action on sets of this type produced after June 1, 1971.

In all cases where emission was observed, the maximum emission was found at the front center of the picture tube or from the upper back right hand corner.

From the data presented, it is concluded that the cause of radiation is excessive high voltage on the picture tube.

Comments

When this receiver's high voltage was adjusted for normal conditions at 120 VAC line, the maximum voltage attainable was approximately 24 kV by turning the high voltage control to its maximum position. The manufacturer recommended that the picture tube be operated at 25 kV. Therefore, something was wrong with the circuitry regulating the high voltage. A high frequency squeal was also present when the set was turned on. Replacement of a 6HZ6 tube corrected the problem.

The measurements with a defective shunt tube were carried out at position Front 5 instead of Back 3 for the following reason. Using the Stoms meter, a reading of 72.00 was seen at Back 3 while Front 5 yielded 70.00. It was impossible to get the 440 RF close enough to the back due to the wiring connections without the danger of high voltage shock. The 440 RF read only 3 mR/hr at the closest proximity possible. However, at 5 cm from the Front 5 position, a reading of 10.6 mR/hr was found. All further readings were therefore taken at Front 5 whenever the defective shunt tube was in the set.

As an evaluation of the effect of line voltage on radiation emission, the receiver was set-up under conditions of the June 1, 1971, standard criteria. The line voltage was then lowered to the point at which 0.5 mR/hr was recorded. The value at which this occurred was 115 VAC.

Recommendations

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from (a) maladjustment of service controls or/and (b) a defective shunt regulator tube. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them, (2) redesigning the receiver to eliminate the shunt regulator tube, (3) installing circuits to limit and control the high voltage applied to X-ray emitting parts even in the event of component or circuitry failure, or to accomplish this indirectly by regulating the input power supply voltage.

Report of Laboratory Tests on Muntz Model No. 1581-2

RECEIVER IDENTIFICATION DATA

Manufacturer:	TV Manufacturers of America	Cabinet Style:	Home Entertainment Unit
Brand Name:	Muntz	Cabinet Material:	Wood
Model Number:	1581-2	Picture Tube:	RCA 21GUP22
Chassis Number:	9015-4	Rectifier Tube:	GE 3A3A
Serial Number:	60416	Shunt Reg. Tube:	RCA 6BK4B
Production Date:	July 1969	Recommended H.V.:	25.0 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	0.10	6.10
Stoms Meter (units)	0.90	60.0
Picture Voltage (kV)	26.8	34.6
Picture Current (mA)	0.30	0.17
Shunt Current (mA)	0.68	0.00
Source of Radiation	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	23.3
Picture Current (mA)	1.14
Shunt Current (mA)	0.05
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.00	0.00	3.20
Stoms Meter (units)	0.00	0.00	42.0
Picture Voltage (kV)	26.1	26.1	34.4
Picture Current (mA)	0.40	0.40	0.15
Shunt Current (mA)	0.85	0.85	0.00
Line Voltage (V)	130	130	130
Source of Radiation			Picture tube
Location of Radiation			Front 5

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Analysis of Data

In this report, Table I is a repeat of the measurements taken in the field. The radiation measurements taken during the in-plant survey were approximately the same as those above. Different values of picture tube voltage and current in the laboratory were found to produce the higher radiation during the defective shunt test.

Table II shows the radiation emitted from the receiver under normal operating conditions. The data indicates negligible X-ray levels in this situation.

Table III includes those radiation tests pertaining to the performance standard for television receivers. Column 1 refers to the first portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts line and all user controls adjusted so as to produce maximum radiation. Thus, the product tested would meet the requirement for receivers to be manufactured subsequent to January 15, 1970.

Column 2 refers to the second portion of the standard. It was noted that X-ray emission from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts with the high voltage service control set at maximum and user controls adjusted to produce maximum radiation. Thus, the product tested would meet the standard for receivers to be manufactured subsequent to June 1, 1970.

Column 3 refers to the third portion of the standard. It was noted that X-ray emissions from the receiver were above 0.5 mR/hr with service and user controls adjusted for maximum emission and conditions identical to those which result from a component or circuit failure (i.e., a defective shunt regulator tube).

Comments

This receiver is equipped with a high voltage hold-down circuit. In this design, the high voltage adjust has been removed to ensure a low-voltage level. However, the design apparently did not function properly with a defective shunt regulator tube in the receiver and resulted in the excessive X-ray emission. It was necessary to reduce the line voltage in this case to 121 volts to achieve less than 0.5 mR/hr from the front of the receiver.

When the defective shunt tube was inserted into the receiver, the H. V. rectifier tube malfunctioned. It was replaced with a GE 3A3A and the set operated properly.

In all cases where emission was observed, it was emanating from the front center of the picture tube and was due to excessive high voltage.

Recommendations

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from a defective shunt regulator tube. This might be achieved for example by (1) redesigning the receiver to eliminate the shunt regulator tube, or (2) installing circuits to limit and control the high voltage applied to X-ray emitting parts even in the event of component or circuitry failure, to accomplish this indirectly by regulating the input power supply voltage.

Report of Laboratory Tests on Olympic Model No. CT400

RECEIVER IDENTIFICATION DATA

Manufacturer:	Nippon Columbia	Cabinet Material:	Metal
Brand Name:	Olympic	Picture Tube:	Hitachi 15SP22 (labelled Olympic)
Model Number:	CT400		
Chassis Number:	CT400	Rectifier Tube:	Toshiba 3AT2 (labelled Olympic)
Serial Number:	B017055		
Production Date:	March 1969	Shunt Reg. Tube:	None
Cabinet Style:	Portable	Recommended H.V.:	22.0 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	3.40	
Stoms Meter (units)	49.0	
Picture Voltage (kV)	27.4	
Picture Current (mA)	0.15	
Shunt Current (mA)	N/A	
Source of Radiation	Picture tube	
Location of Radiation	Back 2	

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.10
Stoms Meter (units)	0.80
Picture Voltage (kV)	22.0
Picture Current (mA)	0.06
Shunt Current (mA)	N/A
Line Voltage (V)	120
Source of Radiation	Picture tube
Location of Radiation	Back 2

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.35	2.00	
Stoms Meter (units)	5.00	26.5	
Picture Voltage (kV)	23.8	25.5	
Picture Current (mA)	0.07	0.26	
Shunt Current (mA)	N/A	N/A	
Line Voltage (V)	130	130	
Source of Radiation	Picture tube	Picture tube	
Location of Radiation	Back 2	Back 2	

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Analysis of Data

In the process of analyzing the data taken, it will be helpful to refer to the comments section of this report for additional information and data.

The measurements taken in the field and the repeat of these measurements in the laboratory are in close agreement. Table I presents the data taken in the laboratory that corresponds to the field survey data.

By referring to the normal operating conditions data (Table II) which simulated proper operation in the home, it is evident that the 0.1 mR/hr measured in this ideal state is within the limit of 0.5 mR/hr.

The measurements that refer to the first phase of the standard, which allows adjustment of only user controls for maximum emission, are presented in Table III, Column 1. The reading of 0.35 mR/hr is a significant reading, but is within the limits of this phase of the standard scheduled to go into effect January 15, 1970.

The data corresponding to the second phase of the standard which permits adjustment of both user and service controls for maximum emission are presented in Table III, Column 2. With the high voltage control set to its maximum position, the observed X-radiation emission of 2.0 mR/hr on the 440 RF clearly indicates that this receiver, were it manufactured after June 1, 1970, would not comply with the standard of 0.5 mR/hr.

There are no data representative of the third phase of the standard, which allows for measurements to be made with component and/or circuit failures that maximize X-radiation emission using both user and service controls.

Under all of the laboratory tests, the excessive radiation was emitted from the neck of the picture tube near the anode cap connection. Even though the high voltages measured on the picture tube were sufficient to produce X-radiation, it is felt that this foreign made tube may be partially at fault. The picture tube has very little current capacity (and consequently a dim picture) unless the high voltage control is turned to its maximum position, which would be the tendency in order to increase picture brightness. When this happens, the tube emits radiation in excess of the standard.

Comments

When this receiver was first tested in the laboratory, the manufacturer's recommended high voltage setting was not available. However, to get what was considered a normal picture on the receiver at 120 VAC line voltage, the high voltage control had to be set to its maximum position. At this setting, the high voltage was measured to be 24.6 kV at minimum brightness. Using these conditions, measurements of 0.5 mR/hr under normal operating conditions and 2.0 mR/hr under the terms of the first phase of the standard were obtained.

At that time it was decided to purchase another picture tube of this type and manufacturer and also one make by a domestic manufacturer. Since an American-made tube could not be found at that time, only the foreign-make tube was purchased. The recommended high voltage setting was also requested from Olympic.

About the same time as the new picture tube arrived, so did the manufacturer's recommended high voltage setting of 22.0 kV at minimum brightness and 120 VAC line. The previous measurements were then repeated on the original tube using this new value and those values are presented in Table II and III. It should be noted that these readings were taken with a dim, but viewable, picture.

Next, the new tube was installed in the receiver and all radiation measurements were repeated at the 22.0 kV recommended high voltage. These readings were essentially the same as those observed on the original tube, partially confirming the consistency of the results from this particular tube.

Recommendations

If the manufacturer (or distributor) continues to use this picture tube, he should have some sort of circuit or shielding in the receiver that will prevent the production of excessive X-ray exposure rates external to the receiver because of service control maladjustment. Before any further conclusions are drawn concerning this picture tube, it is recommended that an American-made replacement tube be tested as a substitute. Several replacements are made by U.S. manufacturers, for the picture tube in question. Comparative readings should be made to see if the replacement tubes perform in the same manner as the original tube. Problems with this low-current capacity picture tube can be foreseen in the future, because of the need to set maximum high voltage to attempt to obtain a viewable picture with the expected brightness.

Report of Laboratory Tests on Olympic Model No. CT911

RECEIVER IDENTIFICATION DATA

Manufacturer:	Nippon Columbia	Cabinet Material:	Metal
Brand Name:	Olympic	Picture Tube:	Toshiba 19GYP22 (labelled Olympic)
Model Number:	CT911		
Chassis Number:	CT911	Rectifier Tube:	Toshiba 3AT2 (labelled Olympic)
Serial Number:	B018670		
Production Date:	March 1969	Shunt Reg. Tube:	None
Cabinet Style:	Portable	Recommended H.V.:	22.0 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	2.40	
Stoms Meter (units)	36.0	
Picture Voltage (kV)	27.6	
Picture Current (mA)	0.15	
Shunt Current (mA)	N/A	
Source of Radiation	Picture tube	
Location of Radiation	Back 4	

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.05
Stoms Meter (units)	0.60
Picture Voltage (kV)	20.6
Picture Current (mA)	0.53
Shunt Current (mA)	N/A
Line Voltage (V)	120
Source of Radiation	Picture tube
Location of Radiation	Back 4

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.50	1.85	
Stoms Meter (units)	7.60	23.0	
Picture Voltage (kV)	23.3	26.1	
Picture Current (mA)	0.34	0.20	
Shunt Current (mA)	N/A	N/A	
Line Voltage (V)	130	130	
Source of Radiation	Picture tube	Picture tube	
Location of Radiation	Back 4	Back 4	

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Analysis of Data

Laboratory testing of this receiver has produced radiation data which corresponds very closely with that data gathered during the in-plant survey in July. Table I contains the laboratory results obtained under set-up conditions identical to the field survey.

Table II summarizes the results obtained when the receiver was operated under the manufacturer's set-up recommendations. A low emission rate was detected under these conditions.

Table III consists of two columns of data relevant to the standard. The first column shows measurements under conditions of user control adjustments for maximum emission. Since the value is just at the standard of 0.5 mR/hr, this receiver, if manufactured after January 15, 1970, would just barely comply with the standard. The second column is maximum emission data gathered under conditions of service and user control adjustments. As of June 1, 1970, a set with the measured values of emission would not meet the standard and corrective action would be necessary.

In all cases where emission was observed, the maximum emission was at the picture tube. The area of maximum emission was located at the back-left side of the receiver.

The reason for emission can be considered from two different viewpoints in the case of this receiver. First of all, the data show that excessive high voltage on the picture tube was the direct cause of X-ray production. The second consideration results from the values of high voltages.

Excessive radiation was observed at voltage values much less than those at which American made picture tubes of the same size were found to emit.

Comments

In surveying this unit, radiation was not limited to the location previously described. It was found on the entire back surface of the set.

As an evaluation of the effect of line voltage on radiation emission, the receiver was set-up under the conditions of the June 1, 1970, standard criteria. The line voltage was then lowered to the point at which 0.5 mR/hr was recorded. The value at which this occurred was 125 VAC.

Recommendations

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from maladjustment of service controls. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them, or (2) installing circuits to limit and control the high voltage applied to X-ray emitting parts. In addition, it is felt that due to the low value of high voltage which produced excessive radiation, the Product Testing and Evaluation Branch should purchase a replacement tube for this receiver from a manufacturer other than Toshiba in order to compare its emission capability at these low voltages.

Report of Laboratory Tests on
Packard Bell Model No. CQ322

RECEIVER IDENTIFICATION DATA

Manufacturer:	Matsushita	Cabinet Material:	Plastic
Brand Name:	Packard Bell	Picture Tube:	320CB22 (labelled Packard Bell)
Model Number:	CQ322		
Chassis Number:	NA	Rectifier Tube:	3A3 (labelled Packard Bell)
Serial Number:	533971		
Production Date:	November 1968	Shunt Reg. Tube:	None
Cabinet Style:	Portable	Recommended H.V.:	21.0 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	0.60	
Stoms Meter (units)	12.0	
Picture Voltage (kV)	24.0	
Picture Current (mA)	0.32	
Shunt Current (mA)	N/A	
Source of Radiation	Picture tube	
Location of Radiation	Top 5	

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	19.8
Picture Current (mA)	0.35
Shunt Current (mA)	N/A
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.00	0.20	
Stoms Meter (units)	0.10	3.80	
Picture Voltage (kV)	20.4	24.7	
Picture Current (mA)	0.30	0.06	
Shunt Current (mA)	N/A	N/A	
Line Voltage (V)	130	130	
Source of Radiation	Picture tube	Picture tube	
Location of Radiation	Top 5	Top 4	

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Analysis of Data

In this report, Table I is a repeat of the measurements taken in the field. The radiation measurements taken during the in-plant survey were approximately the same as those above. The difference can be attributed to normal experimental errors during the field operation.

Table II shows the radiation emitted from the receiver under normal operating conditions. The data indicate negligible X-ray levels in this situation.

Table III includes those radiation tests pertaining to the performance standard for television receivers. Column 1 refers to the first portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts line and all user controls adjusted so as to produce maximum radiation. Thus, the product tested would meet the requirements for receivers to be manufactured subsequent to January 15, 1970.

Column 2 refers to the second portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts with the high voltage service control set at maximum and the user controls adjusted to produce maximum radiation. Thus, the product tested would meet the standard for receivers to be manufactured subsequent to June 1, 1970.

Column 3 refers to the third portion of the standard. No tests were made applicable to defective individual components or circuit failures.

Comments

The X-ray emission from this receiver was intermittent and the characteristics of the picture were unstable at 135 volts line. Measurements ranged from 0.2 mR/hr to 0.6 mR/hr.

Recommendations

We recommend that the manufacturer be informed that the measurements of this receiver showed that it was capable of complying with the performance standard.

Report of Laboratory Tests on Sears Model No. 4074

RECEIVER IDENTIFICATION DATA

Manufacturer: Toshiba
Brand Name: Sears
Model Number: 4074
Chassis Number: 56210523
Serial Number: 51667686
Production Date: May 1969
Cabinet Style: Portable

Cabinet Material: Plastic
Picture Tube: Toshiba 16CYP22 (labelled Sears)
Rectifier Tube: Toshiba 3AT2 (labelled Sears)
Shunt Reg. Tube: None
Recommended H.V.: 18.5 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	2.50	
Stoms Meter (units)	34.0	
Picture Voltage (kV)	25.2	
Picture Current (mA)	0.29	
Shunt Current (mA)	0.00	
Source of Radiation	Picture tube	
Location of Radiation	Back 2	

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.10
Picture Voltage (kV)	19.0
Picture Current (mA)	0.65
Shunt Current (mA)	N/A
Line Voltage (V)	120
Source of Radiation	Picture tube
Location of Radiation	Back 2

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.05	1.60	
Stoms Meter (units)	0.10	16.0	
Picture Voltage (kV)	20.0	24.3	
Picture Current (mA)	0.09	0.25	
Shunt Current (mA)	N/A	N/A	
Line Voltage (V)	130	130	
Source of Radiation	Picture tube	Picture tube	
Location of Radiation	Back 2	Back 2	

Analysis of Data

Table I is a repeat of the measurements taken in the field. The data above differs significantly from that of the in-plant survey. Apparently the maximum point of emission was overlooked during the field survey.

Table II shows the radiation emitted from the receiver under normal operating conditions. The data indicated negligible X-ray levels in this situation.

Table III included those radiation tests pertaining to the performance standard for television receivers. Column 1 refers to the first portion of the standard. It was noted that X-ray emissions from the receiver fell below 0.5 mR/hr at the maximum rated voltage of 130 volts line and all user controls adjusted so as to produce maximum radiation.

Column 2 refers to the second portion of the standard. It was noted that X-ray emissions from the receiver were above 0.5 mR/hr at the maximum rated voltage of 130 volts with the high voltage service control set at maximum 24.3 kV, and user controls adjusted to produce maximum radiation. Thus, the product tested would not meet the standard for receivers to be manufactured subsequent to June 1, 1970.

Column 3 refers to the third portion of the standard. No tests were made applicable to defective individual components or circuit failures.

Comments

In the field, no radiation was noted in excess of 0.5 mR/hr from this receiver. The set was purchased in the belief that a small beam of X-rays was being emitted from the rectifier tube. This was an unusual situation which warranted further investigation. Upon examination in the laboratory, no rectifier emission could be found. However, excessive X-ray exposure rates were detected from the rear of the picture tube when the voltage was elevated.

Recommendations

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from maladjustment of service controls. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them, or (2) installing circuits to limit and control the high voltage applied to X-ray emitting parts.

Report of Laboratory Tests on Setchell Carlson Model No. 3100

RECEIVER IDENTIFICATION DATA

Manufacturer:	Setchell Carlson	Cabinet Material:	Wood
Brand Name:	Setchell Carlson	Picture Tube:	RCA 15MP22
Model Number:	3100	Rectifier Tube:	GE 3A3A
Chassis Number:	U812		(labelled Setchell Carlson)
Serial Number:	576492	Shunt Reg. Tube:	None
Production Date:	July 1969	Recommended H.V.:	21.5 kV
Cabinet Style:	Portable		

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	0.70	
Stoms Meter (units)	13.0	
Picture Voltage (kV)	28.6	
Picture Current (mA)	0.34	
Shunt Current (mA)	N/A	
Source of Radiation	Picture tube	
Location of Radiation	Front 8	

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440 RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	21.1
Picture Current (mA)	0.58
Shunt Current (mA)	N/A
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.00	0.20	
Stoms Meter (units)	0.10	3.80	
Picture Voltage (kV)	23.0	27.7	
Picture Current (mA)	0.60	0.24	
Shunt Current (mA)	N/A	N/A	
Line Voltage (V)	130	130	
Source of Radiation	Picture tube	Picture tube	
Location of Radiation	Front 8	Front 8	

Analysis of Data

The measurements taken in the field and the repeat of these measurements in the laboratory are in close agreement even though the laboratory readings are slightly lower. Table I presents the data taken in the laboratory that corresponds to the field survey data.

By referring to the normal operating conditions data (Table II) which simulates proper operation in the home, it is evident that the receiver did not produce any measurable radiation when operated in this ideal state.

The data corresponding to the first phase of the standard, which allows adjustment of only user controls for maximum emission, are presented in Table III, Column 1. These readings were insignificant, indicating that this receiver would meet the January 15, 1970, phase of the standard.

The measurements that refer to the second phase of the standard, which permits adjustment of both user and service controls for maximum emission are presented in Table III, Column 2. With the high voltage control set to its maximum position, the observed X-radiation emission of 0.2 mR/hr is less than the standard of 0.5 mR/hr proposed to go into effect June 1, 1970.

No data representative of the third phase of the standard were developed. This allows for measurements to be made with component and/or circuit failures that maximize X-radiation emission using both user and service controls. This phase of the standard is scheduled to go into effect June 1, 1971.

The source of the small amount of radiation measured was the picture tube.

Comments

Some operating problems were encountered in the laboratory due to the poor electrical connections made by the plug-in circuit boards inside the receiver.

When this set arrived at the laboratory, there was a crack in the upper right hand corner of the plastic molding around the picture. The damage, which occurred during shipment, was minor and did not affect the laboratory measurements.

Recommendations

We recommend that the manufacturer be informed that the measurements of this receiver showed that it was capable of complying with the performance standard.

Report of Laboratory Tests on Setchell Carlson Model No. 9MC903B

RECEIVER IDENTIFICATION DATA

Manufacturer:	Setchell Carlson	Cabinet Material:	Metal
Brand Name:	Setchell Carlson	Picture Tube:	RCA 19GWP22
Model Number:	9MC903B	Rectifier Tube:	GE 3A3A (labelled Setchell Carlson)
Chassis Number:	U903B		
Serial Number:	581634	Shunt Reg. Tube:	RCA 6BK4B (labelled Setchell Carson)
Production Date:	August 1969		
Cabinet Style:	Monitor	Recommended H.V.:	25.0 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	10.9	13.0
Stoms Meter (units)	81.0	77.0
Picture Voltage (kV)	37.9	41.5
Picture Current (mA)	0.55	0.40
Shunt Current (mA)	0.00	0.00
Source of Radiation	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	24.3
Picture Current (mA)	0.62
Shunt Current (mA)	0.71
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.20	5.40	9.50
Stoms Meter (units)	0.00	58.0	N/A
Picture Voltage (kV)	26.5	36.5	40.5
Picture Current (mA)	0.52	0.54	N/A
Shunt Current (mA)	0.89	0.10	N/A
Line Voltage (V)	130	130	130
Source of Radiation	Picture tube	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5	Front 5

Analysis of Data

Under the maximum condition test in the field, the surveyors could increase the line voltage to only 124 volts before arcing developed. Due to this, the data in Table I cannot be compared with the field data; however, higher values, as expected were found at a higher line voltage of 135 VAC which it was capable of maintaining for short periods of time in the laboratory.

Table II summarizes the results obtained where the receiver was operated under the manufacturer's set-up recommendations. No radiation was detectable under these conditions.

Table III consists of three columns of data relevant to the standard. The first column shows measurements under conditions of user control adjustments for maximum emissions. Since 0.2 mR/hr is within the standard, no action is necessary. The second column contains maximum emission data gathered under conditions of service and user control adjustments. This monitor, if manufactured after June 1, 1970, would exceed the maximum allowable level in the standard and corrective procedures would have to be undertaken. The third column, showing the highest emission rate obtained, 9.5 mR/hr, concerns that part of the standard which covers circuit and failures. This problem would require corrective action on sets of this type if produced after June 1, 1971.

In all cases where emission was observed, the maximum exposure rates were measured at the front center of the picture tube.

From the data presented, it was concluded that the cause of radiation is excessive high voltage on the picture tube.

Comments

This receiver, at its maximum high voltage and line voltage, arced occasionally to the metal cabinet from the cap on the shunt regulator tube. A continuous slow discharge was also observed at elevated voltages.

As an evaluation of the effect of line voltage on radiation emission, the receiver was set up under the conditions of the June 1, 1970 standard criteria. The line voltage was then lowered to the point at which 0.5 mR/hr was recorded. The value at which this occurred was 115 VAC. Similarly, corresponding to the June 1, 1971 portion, with the defective shunt regulator tube, the line voltage had to be lowered to 116 VAC to reach 0.5 mR/hr.

During the defective shunt regulator tube test at 130 VAC, the set began to arc continually from the picture tube at the magnetic shield. This occurred before the Stoms meter and current readings could be taken. Several days later, in looking over the data, it was discovered that at the recommended high voltage setting (Table III, Column 1), the Stoms meter reading had not been recorded. Retesting, under these conditions, neither instrument, the 440 RF or the Stoms, indicated any radiation. This inability to reproduce readings was probably due to the stresses that were put on the set during the other tests.

Recommendations

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from (a) maladjustment of service controls or/and (b) a defective shunt regulator tube. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them,(2) redesigning the receiver to eliminate the shunt regulator tube, (3) installing circuits to limit and control the high voltage applied to X-ray emitting parts even in the event of component or circuitry failure, or to accomplish this indirectly by regulating the input power supply voltage.

Report of Laboratory Tests on Setchell Carlson Model No. 2200

RECEIVER IDENTIFICATION DATA

Manufacturer:	Setchell Carlson	Cabinet Material:	Wood
Brand Name:	Setchell Carlson	Picture Tube:	RCA 19GWP22
Model Number:	2200	Rectifier Tube:	GE 3A3A
Chassis Number:	U806		(labelled Setchell Carlson)
Serial Number:	564584	Shunt Reg. Tube:	GE 6BK4B
Production Date:	October 1968		(labelled Setchell Carlson)
Cabinet Style:	Console	Recommended H.V.:	25.0 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	5.00	6.00
Stoms Meter (units)	78.0	70.0
Picture Voltage (kV)	35.2	34.5
Picture Current (mA)	0.45	0.45
Shunt Current (mA)	0.00	0.00
Source of Radiation	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	24.7
Picture Current (mA)	0.68
Shunt Current (mA)	0.33
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEAUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.00	1.80	3.20
Stoms Meter (units)	0.00	38.0	54.0
Picture Voltage (kV)	25.2	32.8	33.6
Picture Current (mA)	0.44	0.32	0.38
Shunt Current (mA)	0.76	0.00	0.00
Line Voltage (V)	130	130	130
Source of Radiation	Picture tube	Picture tube	Picture tube
Location of Radiation	Front 5	Front 5	Front 5

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Analysis of Data

Under the maximum condition test in the field with the receiver intact, slightly higher readings were obtained than those recorded in Table I. The readings with the defective shunt in the receiver do not compare. However, this was due to a misinterpretation of the testing procedure by the field survey team.

Table II summarizes the results obtained when the receiver was operated under the manufacturer's set-up recommendations. No radiation was detectable under these conditions.

Table III consists of three columns of data relevant to the standard. The first column shows measurements under conditions of user control adjustment for maximum emission. This unit complies with the January 15, 1970, portion of the standard. The second column is maximum emission data gathered under conditions of service and user control adjustments. This receiver, if manufactured after June 1, 1970, would exceed the maximum allowable level and correction procedures would have to be taken. The third column, showing the highest emission rate obtained, 3.2 mR/hr, determines that corrective action will be required after June 1, 1971, for this design.

In all cases where emission was observed, the maximum exposure rates were measured at the front center of the picture tube.

From data presented, it is concluded that the cause of radiation is related to excessive high voltage on the picture tube.

Comments

At maximum high voltage, if the brightness is varied from maximum to minimum while monitoring the high voltage swing, a change of 11,000 volts is observed. This shows that the set is not regulating properly. At normal operating conditions, the high voltage swing is 1,000 volts.

As an evaluation of the effect of line voltage on radiation emission, the receiver was set up under the conditions of June 1, 1970, standard criteria. The line voltage was then lowered to the point at which 0.5 mR/hr was recorded. The value at which this occurred was 119 VAC. Similarly, corresponding to the June 1, 1971 portion using the defective shunt regulator tube, the line voltage had to be lowered to 117 VAC to reach 0.5 mR/hr.

Recommendations

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from (a) maladjustment of service controls or/and (b) a defective shunt regulator tube. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them, (2) redesigning the receiver to eliminate the shunt regulator tube, (3) installing circuits to limit and control the high voltage applied to X-ray emitting parts even in the event of component or circuitry failure, or to accomplish this indirectly by regulating the input power supply voltage.

Report of Laboratory Tests on Setchell Carlson Model No. 3000

RECEIVER IDENTIFICATION DATA

Manufacturer:	Setchell Carlson	Cabinet Material:	Wood
Brand Name:	Setchell Carlson	Picture Tube:	RCA 25XP22
Model Number:	3000	Rectifier Tube:	GE 3A3A
Chassis Number:	U811		(labelled Setchell Carlson)
Serial Number:	576564	Shunt Reg. Tube:	RCA 6BK4B
Production Date:	July 1969		(labelled Setchell Carlson)
Cabinet Style:	Console	Recommended H.V.:	25.0 kV

TABLE I: MAXIMUM RADIATION MEASUREMENTS AT 135VAC LINE

	Receiver Intact	Defective Shunt
Victoreen 440RF (mR/hr)	3.00	2.70
Stoms Meter (units)	70.0	70.0
Picture Voltage (kV)	36.0	35.5
Picture Current (mA)	0.67	0.80
Shunt Current (mA)	0.00	0.00
Source of Radiation	Picture tube	Picture tube
Location of Radiation	Left 6	Left 6

TABLE II: RADIATION MEASUREMENTS UNDER NORMAL OPERATING CONDITIONS

Victoreen 440RF (mR/hr)	0.00
Stoms Meter (units)	0.00
Picture Voltage (kV)	24.4
Picture Current (mA)	0.72
Shunt Current (mA)	0.64
Line Voltage (V)	120
Source of Radiation	
Location of Radiation	

TABLE III: RADIATION MEASUREMENTS CORRESPONDING TO THE PHASES OF THE STANDARD

	Phase I (Jan. 15, 1970)	Phase II (June 1, 1970)	Phase III (June 1, 1971)
Victoreen 440RF (mR/hr)	0.00	2.10	2.00
Stoms Meter (units)	0.10	60.0	39.0
Picture Voltage (kV)	26.4	35.5	35.0
Picture Current (mA)	0.97	0.65	0.70
Shunt Current (mA)	0.53	0.00	0.00
Line Voltage (V)	130	130	130
Source of Radiation	Picture tube	Picture tube	Picture tube
Location of Radiation	Left 6	Left 6	Left 6

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Analysis of Data

Under the maximum conditions test in the field, the surveyors could increase the line voltage to only 124 VAC before arcing developed. Due to this, the data in Table I cannot be compared with the field data; however, higher values, as expected were found at the higher line voltage of 135 VAC.

Table II summarizes the results obtained when the receiver was operated under the manufacturer's set-up recommendations. No radiation was detectable under these conditions.

Table III consists of three columns of data relevant to the standard. The first column shows measurements under conditions of user control adjustments for maximum emission. This unit complies with the January 15, 1970 portion. The second column is maximum emission data gathered under conditions of service and user control adjustments. If this receiver were manufactured after June 1, 1970, it would exceed the maximum allowable level and corrective procedures would have to be undertaken. The third column contains data corresponding to component failure. In this instance, if the shunt regulator tube failed, this receiver would not meet the requirements if it were produced after June 1, 1971.

In all cases where X-radiation was observed, the maximum exposure rates were measured at the front center of the picture tube.

From the data presented, it is concluded that the cause of radiation is related to excessive high voltage on the picture tube.

Comments

The problem of arcing when the line was increased above 124 VAC in the field did not repeat in the laboratory testing. There are two possible causes: the humidity could have been high and therefore the set was not dried out; or, bad connections in the field with sharp edges increased the probability of arcing.

When the high voltage control was turned up, a point was reached at which the shunt regulator tube ceased to function; therefore, the high voltage regulation was absent at this time. As the brightness was varied, a 4000 volt swing was observed.

As an evaluation of the effect of line voltage on radiation emission, the receiver was set up under the conditions of June 1, 1970 standard criteria. The line voltage was then lowered to the point at which 0.5 mR/hr was recorded. The value at which this occurred was 117 VAC. Similarly, corresponding to June 1, 1971 portion, using the defective shunt regulator tube, the line voltage had to be lowered to 118 VAC to reach 0.5 mR/hr.

Recommendations

Provision must be made to prevent the production of excessive X-ray exposure rates resulting from (a) maladjustment of service controls or/and (b) a defective shunt regulator tube. This might be achieved for example by (1) redesigning the receiver to limit the range of controls or eliminating them (2) redesigning the receiver to eliminate the shunt regulator tube, (3) installing circuits to limit and control the high voltage applied to X-ray emitting parts even in the event of component or circuitry failure, or to accomplish this indirectly by regulating the input power supply voltage.

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VII. ANALYSIS OF TEST RESULTS

Tables A through D present a summary of the data obtained during the laboratory product testing of the color television receivers acquired by the Division. In the tables, "Brand" refers to the name under which the receivers are marketed. The Brand may or may not refer to the actual manufacturer of the receivers.

By referring to Table A, which lists the data relating to the various phases of the standard, it can be seen how the receivers as a group conformed to the standard. Under Phase I, only one receiver (Olympic model CT 911) emitted radiation equivalent to the standard. It is questionable whether or not this receiver would comply with the January 15, 1970 phase of the standard were it manufactured after that date. By referring to the individual receiver's reports, it will be noted that two other receivers (Olympic model CT400 and Curtis Mathes model 52M594) would have failed to comply with the first phase of the standard were the high voltage control adjusted for what was considered to be the best viewable picture.

Table A also shows that of the 22 receivers tested, 12 would not meet the requirements of Phase II of the standard which is scheduled to go into effect June 1, 1970.

Of the receivers tested, 13 had shunt regulator tubes and all 13 of these receivers failed to comply with Phase III of the standard when a defective shunt regulator tube was substituted for the original tube in the receiver.

Finally, it was observed that three of the receivers tested met the requirements of the first two phases of the standard. These sets were Motorola model CT665EW, Packard Bell model CQ322, and Setchell Carlson model 3100.

Table B gives the source, location, and cause of the X-radiation emission measured from the receivers. Of all but one of the receivers tested, the picture tube was the primary source of radiation. The source of the radiation from the one set was the shunt regulator tube. Under the defective shunt test, this receiver (Curtis Mathes model 52M742) emitted excessive radiation from the front of the picture tube. Of all the sets not complying with one or more phases of the standard, the primary cause of the X-radiation can be attributed to the high voltage on the emitting component being excessive in terms of the X-ray emission capabilities of the part. Other causes of excessive radiation from the receiver emanating from the shunt regulator tube included poor component self-shielding and insufficient external shielding of the tube. Three of the imported receivers emitted radiation at voltages relatively lower than the values at which domestic picture tubes of the same size were found to emit equally. Thus, the poorer self-shielding quality of these tubes may be a cause of the measured excessive radiation. The radiation

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from these Japanese tubes was emanating from the neck of the picture tube, which tends to indicate that these tubes may have an insufficient amount of absorption material in the glass or simply may be constructed of glass too thin to attenuate X-rays adequately for the voltages available.

The maximum radiation data taken under the conditions of the field surveys are presented in Table C. These were the basis upon which receivers were selected for further testing. The laboratory tests confirmed all except one of the selection judgements made in the field tests. However, that receiver when tested in laboratory (Motorola model CT665FW) was not the identical receiver, but of the same model as that tested in the field.

In general, the field results were reproducible in the laboratory. Any differences are explained in the individual receiver reports.

An interesting observation can be made by comparing the radiation data taken at 135 VAC line voltage (Table C) with that data taken at 130 VAC line voltage (Table A). Radiation exposure rate data taken at 135 VAC line was approximately twice that of comparable data taken at 130 VAC line.

Table D shows that only negligible radiation was measurable when the receivers were operated at 120 VAC line voltage and adjusted to the manufacturer's recommended high voltage.

Table A: Maximum Radiation Data Relating to the Phases of the Standard (See Appendix A)

Brand	Model	Phase I	Phase II	Phase III
Admiral	3L3139	0.05	0.20	1.20
Admiral	8T331C	0.00	4.00	N/A
Andrea	SPECTRA	0.00	0.40	1.50
Coronado	G12K3800644	0.10	0.20	1.50
Curtis Mathes	52M742	0.05	0.90	0.90
Curtis Mathes	52M594	0.00	1.55	N/A
Dumont	55C29	0.00	1.80	2.20
Dumont	59T01W	0.15	0.60	N/A
General Electric	M926EMP	0.00	0.30	0.90
Magnavox	1C6402	0.10	2.30	2.60
Motorola	CT665EW	0.00	0.00	N/A
Muntz	2481FP	0.00	0.25	2.90
Muntz	2181	0.25	0.14	5.40
Muntz	1581-2	0.00	0.00	3.20
Olympic	CT400	0.35	2.00	N/A
Olympic	CT911	0.50	1.85	N/A
Packard Bell	CQ322	0.00	0.20	N/A
Sears	4074	0.05	1.60	N/A
Setchell Carlson	3100	0.00	0.20	N/A
Setchell Carlson	9MC903B	0.20	5.40	9.50
Setchell Carlson	2200	0.00	1.80	3.20
Setchell Carlson	3000	0.00	2.10	2.00

Note: All readings were taken with the Victoreen 440 RF and are given in mR/hr, net of background.

Table B: Source, Location, and Cause of Emission Observed During Laboratory Product Testing

Brand	Model	Source	Location	Cause
Admiral	3L3139	Picture	Front 4	1
Admiral	8T331C	Picture	Front 8	1
Andrea	SPECTRA	Picture	Front 5	1
Coranado	G12K3800644	Picture	Front 5	1
Curtis Mathes	52M742	Shunt	Left 8	1,3,4
		Picture	Front 5	1
Curtis Mathes	52M594	Picture	Back 6	1,2,4
Dumont	55C29	Picture	Front 5	1
Dumont	59T01W	Picture	Top 5, Back 2	1,4
General Electric	M926EMP	Picture	Front 5	1
Magnavox	1C6402	Picture	Front 5	1
Motorola	CT665EW	Picture	Front 4	5
Muntz	2481FP	Picture	Front 5	1
Muntz	2181	Picture	Back 3, Front 5	1,4
Muntz	1581-2	Picture	Front 5	1
Olympic	CT400	Picture	Back 2	1,2,4
Olympic	CT911	Picture	Back 4	1,2
Packard Bell	CQ322	Picture	Top 5, Top 4	5,4
Sears	4974	Picture	Back 2	1,4
Setchell Carlson	3100	Picture	Front 8	5
Setchell Carlson	9MC903B	Picture	Front 5	1
Setchell Carlson	2200	Picture	Front 5	1
Setchell Carlson	3000	Picture	Left 6	1,4

Cause Codes:
1. Excessive High Voltage
2. Picture Tube (component)
3. Shunt Regulator Tube (component)
4. Inadequate Shielding
5. None, receiver is in compliance.

Table C: Maximum Radiation Data Taken Under the Conditions of the In-Plant Survey (V_L = 135 VAC)

Brand	Model	Receiver Intact	Defective Shunt
Admiral	3L3139	0.50	2.40
Admiral	8T331C	8.10	N/A
Andrea	SPECTRA	0.90	3.00
Coranado	G12K3800644	0.50	4.00
Curtis Mathes	52M742	2.00	2.10
Curtis Mathes	52M594	2.90	N/A
Dumont	55C29	2.60	8.60
Dumont	59T01W	1.40	N/A
General Electric	M926EMP	0.90	2.20
Magnavox	1C6402	4.90	5.10
Motorola	CT665EW	0.10	N/A
Muntz	2481FP	0.50	3.20
Muntz	2181	0.20	10.60
Muntz	1581-2	0.10	6.10
Olympic	CT400	3.40	N/A
Olympic	CT911	2.40	N/A
Packard Bell	CQ322	0.60	N/A
Sears	4074	2.50	N/A
Setchell Carlson	3100	0.70	N/A
Setchell Carlson	9MC903B	10.90	13.00
Setchell Carlson	2200	5.00	6.00
Setchell Carlson	3000	3.00	2.70

Note: All readings were taken with the Victoreen 440RF and are given in mR/hr, net of background.

Table D: Radiation Measurements Under Normal Operating Conditions (V_L = 120 VAC)

Brand	Model	Reading
Admiral	3L3139	0.00
Admiral	8T331C	0.00
Andrea	SPECTRA	0.00
Coronado	G12K3800644	0.00
Curtis Mathes	52M742	0.00
Curtis Mathes	52M594	0.00
Dumont	55C29	0.00
Dumont	59T01W	0.00
General Electric	M926EMP	0.00
Magnavox	1C6402	0.00
Motorola	CT665EW	0.00
Muntz	2481FP	0.00
Muntz	2181	0.00
Muntz	1581-2	0.00
Olympic	CT400	0.10
Olympic	CT911	0.05
Packard Bell	CQ322	0.00
Sears	4074	0.00
Setchell Carlson	3100	0.00
Setchell Carlson	9MC903B	0.00
Setchell Carlson	2200	0.00
Setchell Carlson	3000	0.00

Note: All readings were taken with the Victoreen 440 RF and are given in mR/hr, net of background.

VIII. CONCLUSIONS

In reviewing the overall content of this report, one factor emerges as the predominant cause for X-radiation--excessive high voltage on the picture tube. In all cases, if the voltage was held down to within the manufacturer's suggested maximum operating value, no set would have violated the standard. Future sets will have to, therefore, employ circuitry designed to perform this function of high voltage hold-down. It is also evident that to comply with the third part of the standard, and specifically with a defective shunt regulator tube, the voltage hold-down circuit must function properly even in the event of component failure. All 13 of the shunt regulated sets that were tested failed to comply when a faulty shunt tube was placed in the receiver.

Preliminary data seem to show, from the lower voltage-emission threshold observed in the sets using Japanese picture tubes, and from the fact that the location of maximum radiation was always from the back surface of the picture tube, that the Japanese manufacturing technique results in picture tubes that may be more poorly shielded than their American counterparts.

If modifications are not made by the manufacturer on receivers similar in design and construction to those tested for this report, compliance with the second and third phase of the standard will not be possible.

IX. RECOMMENDATIONS

Having the conclusions in mind, it is possible to formulate some future tests that will be made by the Product Testing and Evaluation Branch, as well as other improvements to the X-radiation problem in addition to the high voltage hold-down circuit.

Since a difference was observed between the small Japanese and the American picture tubes, American made replacements for the three sets in question should be purchased to verify the conclusion that there is indeed a constructive difference. Another aspect that may warrant investigation would be a survey of some imports in the home, providing the necessary information on location is available from distributors or manufacturers.

All of the shunt regulated sets failed to pass the third phase of the standard; therefore, if the shunt tube can be replaced with a more reliable form of regulation, this is strongly recommended.

In any event, since 50% lead shunt regulator tubes are now available, they should be utilized to assure maximum absorption when it is working properly. Following along this line, but extending to the picture tube, if the envelopes contained more lead, barium, and strontium carbonate, reduced X-radiation would result.

The procedures followed in testing these 22 receivers resulted in much data which actually are not necessary for compliance testing. The largest portion of this data are the regulation curves which are very time consuming to generate. For any future tests which are undertaken solely for the purpose of gathering compliance data, this portion of the procedure will be eliminated, since nothing would be lost and more sets per day can be tested and evaluated. The manufacturers should also furnish in writing the recommended high voltage setting. In some cases, it was difficult to obtain this information; in others, a discrepancy was found between the schematic information and the value found on the chassis.

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REFERENCES

1. REITER, STEPHEN E., MARSHALL I. POMER, ALBERT B. STROJNI, DONALD R. SMITH, and THOMAS M. SMITH. Summary Report on Visits to Manufacturers - In-Plant Survey of Television Receivers for X-radiation Emission Capability. Unpublished report.

2. STOMS, RICHARD K. and EDWARD KUERZE. Instrument for Measurement of X-ray Emission from Television Sets. Technical Services Branch, National Center for Radiological Health, TSB Report No. 1 (January 1968).

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Appendix A.

PERFORMANCE STANDARD FOR TELEVISION RECEIVERS

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DEPARTMENT OF

HEALTH, EDUCATION, AND WELFARE DEPARTMENT

PUBLIC HEALTH SERVICE

Rules and Regulations

PART 78—REGULATIONS FOR THE ADMINISTRATION AND ENFORCEMENT OF THE RADIATION CONTROL FOR HEALTH AND SAFETY ACT OF 1968

Performance Standard for Television Receivers

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PART 78—REGULATIONS FOR THE ADMINISTRATION AND ENFORCEMENT OF THE RADIATION CONTROL FOR HEALTH AND SAFETY ACT OF 1968

Performance Standard for Television Receivers

On October 16, 1969, notice of proposed rule making was published in the FEDERAL REGISTER (34 F.R. 15997) to amend Part 78 by prescribing a performance standard applicable to the emission of x-radiation from television receivers. Also proposed were certain general labeling and certification requirements for any electronic product subject to a performance standard prescribed under the Radiation Control for Health and Safety Act of 1968.

Interested persons were given the opportunity to participate in the rule making through the submission of comments. Pursuant to the notice, a number of comments have been received from interested persons, and due consideration has been given to all relevant material presented.

In light of the comments, a number of changes have been made in the amendments as proposed. The requirements for warnings on critical components of television receivers have been revised, and the certification and labeling sections have been revised to permit inscription on the product.

The Commissioner has determined, therefore, that this standard is necessary for the protection of the public health and safety and further finds that the need for such protection, together with the ability of the industry to meet the standard constitutes good cause for an immediate effective date. Accordingly, the amendments to Part 78, as set forth below, are hereby adopted effective on the date of publication and will be applicable to television receivers manufactured after January 15, 1970.

Subpart C—Performance Standards for Electronic Products

GENERAL PROVISIONS

Sec.
78.200 Scope.
78.201 Certification.
78.202 Labeling.
78.203 Special test procedures.
78.204 Electronic products intended for export.

PERFORMANCE STANDARD

Sec.
78.210 Performance standard for television receivers.

AUTHORITY: The provisions of this Subpart C issued under sec. 358, 82 Stat. 1177; 42 U.S.C. 263f.

Subpart C—Performance Standards for Electronic Products

GENERAL PROVISIONS

§ 78.200 Scope.

The standards listed in this subpart are prescribed pursuant to section 358 of the Radiation Control for Health and Safety Act of 1968 (42 U.S.C. 263f) and are applicable to electronic products as specified herein, to control electronic product radiation from such products. Standards so prescribed are subject to amendment or revocation and additional standards may be prescribed as are determined necessary for the protection of the public health and safety.

§ 78.201 Certification.

(a) Every manufacturer of an electronic product to which an applicable standard is in effect under this subpart, shall furnish to the dealer or distributor at the time of delivery of such product, the certification that such product conforms to all applicable standards under this subpart.

(b) The certification shall be in the form of a label or tag permanently affixed to, or inscribed on such product. In the case of products to which it is not feasible to affix or inscribe the label or tag, upon application therefor, the Secretary may approve other means by which a manufacturer may provide the certification required by this section.

(c) Such certification shall be based upon a test, in accordance with the standard, of the individual article to which it is attached or upon a testing program which is in accordance with good manufacturing practices. The Secretary may disapprove such a testing program on the grounds that it does not assure the adequacy of safeguards against hazardous electronic product radiation or that it does not assure that electronic products comply with the standard prescribed under this subpart.

(d) The certification tag or label or inscription shall be located on the product so as to be legible when the product is fully assembled for use.

§ 78.202 Labeling.

Every manufacterer of an electronic product to which is applicable a standard under this subpart shall, by a label or tag permanently affixed to or inscribed on such product, set forth:

(a) The full name and address of the manufacturer of the product: Abbreviations such as "Co.," "Inc.," or their foreign equivalents and the first and middle initials of individuals may be used. Where products are sold under a name other than that of the manufacturer of the product, the label may set forth the name of the individual or company under whose name the product was sold, provided such individual or company has previously supplied the Secretary with sufficient information to identify the manufacturer of the product.

(b) The month, year, and place of manufacture: This information may be expressed in code provided the manufacturer has previously supplied the Secretary with the key to such codes.

(c) The tag or label shall be located on the product so as to be legible when the product is fully assembled for use.

§ 78.203 Special test procedures.

The Secretary may, on the basis of a written application by a manufacturer, authorize test programs other than those set forth in the standard for an electronic product if he determines that such products are not susceptible to satisfactory testing by the procedures set forth in the standard and that the alternative test procedures assure compliance with the standard.

§ 78.204 Electronic products intended for export.

The performance standard prescribed in this subpart shall not apply to any electronic product which is intended solely for export if (a) such product and the outside of any shipping container used in the export of such product are labeled or tagged to show that such product is intended for export, and (b) such product meets all the applicable requirements of the country to which such product is intended for export.

PERFORMANCE STANDARD

§ 78.210 Performance standard for television receivers.

(a) *Applicability*. The provisions of this section are applicable to television receivers manufactured subsequent to January 15, 1970.

(b) *Definitions*. (1) "External surface" means the cabinet or enclosure provided by the manufacturer as part of the receiver. If a cabinet or enclosure is not provided as part of the receiver, the external surface shall be considered to be a hypothetical cabinet, the plane surfaces of which are located at those minimum distances from the chassis sufficient to enclose all components of the receiver except that portion of the neck and socket of the cathode-ray tube which normally extends beyond the plane surfaces of the enclosure.

(2) "Maximum test voltage" means 130 root mean square volts if the receiver is designed to operate from nominal 110 to 120 root mean square volt power sources. If the receiver is designed to operate from a power source having some voltage other than from nominal 110 to 120 root mean square volts, maximum test voltage means 110 percent of the nominal root mean square voltage specified by the manufacturer for the power source.

(3) "Service controls" means all of those controls on a television receiver provided by the manufacturer for purposes of adjustment which, under normal usage, are not accessible to the user.

(4) "Television receiver" means an electronic product designed to receive and display a television picture through broadcast, cable, or closed circuit television.

(5) "Usable picture" means a picture in synchronization and transmitting viewable intelligence.

(6) "User controls" means all of those controls on a television receiver, provided by the manufacturer for purposes of adjustment, which on a fully assembled receiver under normal usage, are accessible to the user.

(c) *Requirements*—(1) *Exposure rate limit*. Radiation exposure rates produced by a television receiver shall not exceed 0.5 milliroentgens per hour at a distance of five (5) centimeters from any point on the external surface of the receiver, as measured in accordance with this section.

(2) *Measurements*. Compliance with the exposure rate limit defined in subparagraph (1) of this paragraph shall be determined by measurements made with an instrument, the radiation sensitive volume of which shall have a cross section parallel to the external surface of the receiver with an area of ten (10) square centimeters and no dimension larger than five (5) centimeters. Measurements made with instruments having other areas must be corrected for spatial nonuniformity of the radiation field to obtain the exposure rate average over a ten (10) square centimeter area.

(3) *Test conditions*. All measurements shall be made with the receiver displaying a usable picture and with the power source operated at supply voltages up to the maximum text voltage of the receiver and, as applicable, under the following specific conditions:

(i) On television receivers manufactured subsequent to January 15, 1970, measurements shall be made with all user controls adjusted so as to produce maximum x-radiation emissions from the receiver.

(ii) On television receivers manufactured subsequent to June 1, 1970, measurements shall be made with all user controls and all service controls adjusted to combinations which result in the production of maximum x-radiation emissions.

(iii) On television receivers manufactured subsequent to June 1, 1971, measurements shall be made under the conditions described in subdivision (ii) of this subparagraph, together with conditions identical to those which result from that component or circuit failure which maximizes x-radiation emissions.

(4) *Critical component warning.* The manufacturer shall permanently affix or inscribe a warning label, clearly legible under conditions of service, on all television receivers which could produce radiation exposure rates in excess of the requirements of this § 78.210 as a result of failure or improper adjustment or improper replacement of a circuit or shield component. The warning label shall include the specification of operating high voltage and an instruction for adjusting the high voltage to the specified value.

Dated: December 23, 1969.

CHRIS A. HANSEN,
Assistant Surgeon General, Commissioner, Environmental Control Administration.

[F.R. Doc. 69-15297; Filed, Dec. 24, 1969; 8:45 a.m.]

Appendix B

SAFETY PRECAUTIONS AND CONTROLLED FACTORS

In keeping with proper laboratory testing procedures, adequate safety precautions were followed, and as many external factors as feasible were controlled to produce more accurate test results. In an effort to reduce X-radiation exposure to laboratory personnel, television receivers that emitted excessive radiation under certain test conditions were tested in a fast and orderly manner so that the length of receiver operation time in this mode would be minimal. By proper technique (working quickly) there was no radiation "danger" inside the lab either. To monitor the laboratory personnel exposure, all workers were required to wear X-ray film badges when receivers were under test, and wall radiation monitors were mounted in various areas of the lab.

During the laboratory tests, care was taken to reduce or eliminate some of the field testing problems. Due to the stable set-up of the test equipment and proper care of the survey meters, electrical hazards and meter malfunctions were minimal. By using better electrical connectors in the laboratory set-up which were not available in the field, arcing and corona discharge were minimized. Therefore, in addition to reducing the electrical hazard, there was less danger of damaging the receiver.

Another precaution taken to reduce corona discharge was the installation of a portable de-humidifier. By controlling the humidity in the TV lab, corona, which could have altered the laboratory measurements, was reduced. Thus, more meaningful results were obtained. The controlled humidity also eliminated some of the humidity problems with the Stoms survey meter.

The ABSTRACT CARDS below are designed to facilitate document retrieval using Coordinate Indexing. They provide space for an accession number (to be filled in by the user), suggested key words, bibliographic information, and an abstract.

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LABORATORY TESTING AND EVALUATION OF COLOR TELEVISION RECEIVERS ACQUIRED DURING THE IN-PLANT SURVEY - Thomas M. Smith, Paul S. Ruggera, and Stephen W. Smith;
January 1970; BRH/DEP 70-6; DEP, BRH, EHS, PHS, DHEW.

Accession No.

Under the authority granted to the Secretary, Department of Health, Education, and Welfare by Public Law 90-602, the "Radiation Control for Health and Safety Act of 1968," the Division of Electronic Products conducted a field survey of domestic television manufacturers from June 1969 to September 1969 to determine the X-ray emitting capability of television receivers manufactured after October 18, 1968. During this survey various receivers, identified as being capable of emitting X-radiation, were selected for additional Division of Electronic Products

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Color TV, X-radiation, Picture tubes, Shunt regulator tubes, Rectifier tubes

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